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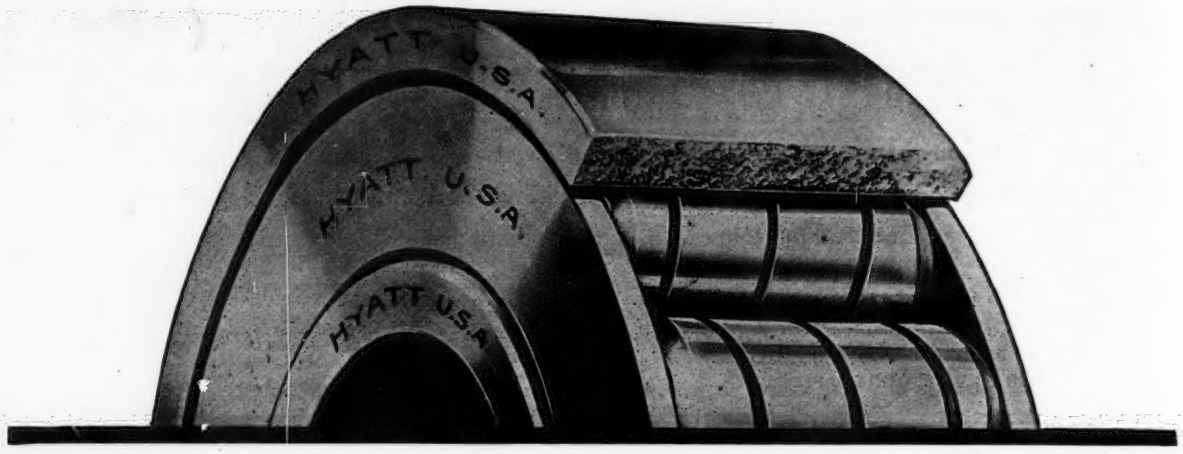

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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

Vol. 7 SEPTEMBER, 1926 No. 9

Agriculture Arrives at the Industrial Revolution*

By Arthur Huntington

Mem. A.S.A.E. Public Relations Engineer, Iowa Railway and Light Corporation

IT IS quite common to hear or read that "American agriculture has come to the parting of the ways," that "agriculture must be placed on an equality with other businesses or go back to peasantry," or that "agriculture must be stabilized."

Agriculture is not at the parting of the ways; the crossroads were passed when the industry accepted the gang plow, the self-binder, the power thresher, the modern railroad, the money of the banker, the quantity handling of agricultural products by the miller and packer. The question at present is: Shall we level up the foundations of business, or shall we put a "shim" under agriculture simply to stop the wabble temporarily?

American agriculture will not go back to peasantry for two very important reasons: (1) No peasant type of farming can compete with American large scale production, and (2) no peasant type of mind can practice the American type of farming.

American agriculture has accepted too many of the practices of the modern industrialized factory ever to hope to retrace its steps. It must industrialize to the place that it can hold its own as a business in an industrialized world.

It must industrialize to the place that it can produce enough in one hour to exchange, in the markets of the world, for that which the man of industry produces in the same time. Agriculture must not be content to devote, as at present, 2.18 hours to manufacture products exchangeable for other products the city man produces in one hour. It must know that industry's producing advantage is an equipment and power advantage which can be easily overcome when agriculture learns to accept those tools the engineer has designed and the manufacturer has made and placed at the disposal of the industry.

Agriculture must learn to think in terms of industry along production lines, that is, to measure production in terms of output per worker and not in terms of output per acre; in output per dollar invested rather than in terms of value per acre.

In industry the capital investment is kept as low as possible for any given volume of business done. In agriculture the capital is inflated without regard to returns and this inflated value has been accepted as the prosperity of agriculture. In some of our agricultural states the increase of land values has been the measure of wealth and the foundation of business prosperity for more than half a century.

Agriculture must know the nature of its investment; it must know that money invested in the land itself turns only once in from six to ten years and that the capital is permanent and that only the profit from crops comes back. It must know that money invested in livestock turns only once in from one to three years, and that it takes a year to raise a crop. The farmer cannot compare his business with the store that turns its capital in 30, 60 or 90 days. He must know that his various types of capital have little relation to each other and that they must be handled as differently as though they were different businesses owned and handled by different men. Our tenant type of farming is doing much to separate the investment in the farm from the business of operating a farm. Many people look with horror at our increasing tenantry, but the time is not far distant when men will occupy their own farms as their own tenants, keeping their farm investment as separate from their farm operations as if they were owned by different persons.

Above all the farmer must know the best standard of practices and think and act in such terms rather than in the terms of average results. No factory man can be interested in average results; he is only interested in the most efficient practices. He knows that only those who are better than the average prosper, that the average factory stays in business but does not prosper and that the factory which falls below average results must go out of business.

The time is not far distant when the farm will cease to be a place to exist. The prosperous farmer will be a man of business capabilities who knows business, who knows costs, who knows efficiency, who knows the nature of his investments, who knows markets, and who follows the best practices.

There will be a class which holds its own but neither makes nor loses money. It must be the lowest class in agriculture. Those who fall below must eventually be eliminated. In fact, American agriculture has cast the die and is proceeding along that line. The back-to-the-farm movement is no longer operative. The farm as a place to live is being replaced by the farm as a place to make money. The time is not far distant when the farm home will be as remote from the farm business as the city man's home is remote from his business, when the farm tenant houses will be in the same class with the city property housing the factory worker.

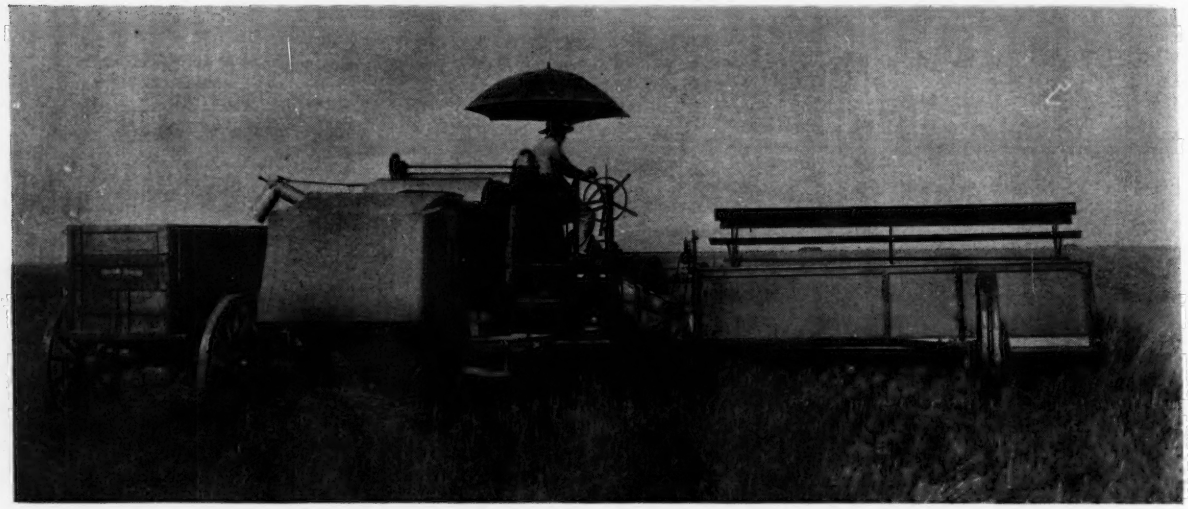
False economics have been put forth in regard to the small, highly productive farm, but let me quote a few figures from the 1920 census. From 1910 to 1920 the farms of less than twenty acres decreased in numbers 5.1 per cent; the farms of from 20 to 49 acres increased 6.3 per cent; whereas, the farms of more than 1000 acres increased 34.4 per cent.

The tendency in American agriculture is away from the twenty-acre peasant type of farm and farming towards the large farm and the business type of farming. The definite trend of American agriculture is toward industrialization. Let us for a moment look at the development of the present factory system and compare it with the present trend of American agriculture.

In the year 1719 at Derbyshire, England, there was installed and put into operation an institution out of which has evolved the modern factory. Prior to that time all manufacturing had been carried on along two general lines, namely: (1) As a part of the home with one artisan as the sole operator and (2) as a part of a guild which was carried on in a group of homes with skilled workmen and a system of apprentices.

In both types the operation was largely hand work executed by a skilled artisan. His helper was an apprentice who some day would carry on the business as his own. There was little or no capital invested for equipment, raw material or finished products. The equipment was of simple home apparatus. Tools suited to the needs of the artisan were made for the particular operation required. Generally speak-

*An address before the 20th annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, Calif., June, 1926.



The greatest single step in the industrialization of wheat production, at least within a generation, is the combine, which by a combination of harvestng and threshing machinery replaces most of the hand labor, makes a single operation from stalk to bag or bulk wagon, and effects a saving in labor and operating costs of about twenty cents a bushel

ing, the ability to make the equipment and tools required were as much a part of the artisan's trade as was the ability to use them after they were made.

With the Derbyshire factory came a long list of changes in the art of producing the needs of man by factory methods and out of it has grown our modern factory system. This change has become known as the "industrial revolution."

Historians and economists have analyzed this period, calling attention to a long list of changes both in methods of producing and disposing of the product, and in the changed living conditions of the people who worked in the factories and those who consumed the commodities produced.

I will not go deeper into the question other than to enumerate some of the problems developed and to point out some of these changes as they apply to modern agriculture.

When the complete factory operation was the result of one pair of hands, it was very necessary to have a complete and comprehensive knowledge of the whole method of manufacture. But with factory methods where the worker was familiar with only one operation repeated over and over again on a machine driven by mechanical power, the skill of the operator began to decline, and at the same time the price of factory-made goods was so low that the home factory could no longer compete. The factory was definitely driven from the home. Henceforth, the factory would stand or fall on its ability to make profits and the home would exist as a place to live.

The natural outcome of such a condition was a "labor problem." Nearly all of our laws governing hours and conditions of labor are the result of new conditions and abuses of personal rights that came with mass production by the unskilled masses, directed by unskilled and many times unscrupulous overlords.

Factories called for capital investment and money with which to buy in quantities and with which to meet payrolls. With the introduction of capital came the profit factor. For many years the profits of the factories either were very great or led to bankruptcy, depending upon the perfection of the mechanical equipment, the skill of management and the financial stability of the company.

The demand for capital in larger quantities called for credit, and with the creditor class came the demand for profits. If the factory was to exist loans had to be repaid from profits.

Profit introduced efficiency and efficiency required a complete analysis of the industry and a knowledge of each item that enters into the make-up of the whole, a knowledge of just how each operation dovetails with other items and how each must enter into a cost of production program.

Efficiency comes largely with output and output must be sold, thus introducing the knowledge of trade channels, markets, selling methods, competitors' activities and a long list of closely related factors.

Stated briefly, the industrial revolution separated the factory and the home, replaced the artisan with the less skilled operator, introducing the labor problem. It brought outside capital into the factory and with it came the demand for a profit factor. It introduced efficient methods which called for mass production and finally a sales organization, all of which must be supervised and directed from a central management understanding raw material, labor, production, sales overhead, and at the same time commanding the respect of capital.

The first American factories had their birth about the time of the adoption of the Constitution and the birth of the steam engine, the first appearing at Beverly, Massachusetts, in 1787, and the second at Pawtucket, Rhode Island, in 1790. The census of the latter year shows approximately 95 per cent of the American people engaged in agriculture and the remaining 5 per cent in the trades, business and artisan pursuits. The figures of that census do not mean that 5 per cent of the people transacted all of the business and made all of the manufactured commodities of that time, but it does point out the extent to which the farm home of that time was a factory.

While each succeeding census records the growth of manufacturing in America, they do not record what part is new development in the field of industry and what part is the taking over and developing of something that had formerly been a part of the accepted farm operations, a part of the factory operation of the farm. Nor does our last census record the fact that the farm was in 1920, and is now in 1926, the largest factory when measured in money invested and number of workers of any of America's great manufacturing plants. The American farm converts more raw material into a valuable finished product than any of our great modern industrial plants.

While the first American factory had its birth more than a century ago, nearly three-fourths of a century after the first European factory, America has surpassed the world in industrial development and has applied modern methods to many industries. However, she has yet much to learn in efficiency, production and marketing. She has yet many industries to analyze and much new equipment to develop and many new business methods to install.

Agriculture, our greatest industry and our greatest business, has yet to avail itself of those things which have made America's manufacturing industries great, and has yet to be

analyzed in such a way that an efficiency statement can be made and intelligently studied. In many respects American agriculture, which is the most advanced agriculture in the world, is now, 1926, operating on a plane equal to the operation of the factories of two centuries ago.

Do not for a moment think that I am belittling the advancement made in agriculture, for American agriculture has advanced farther and faster than any industry in the world, save America's industrialized factories. What I want to make clear is that agriculture has not kept pace with the industries producing those products the farmer buys. It has not employed enough of those methods which have made the American factory great.

Let us for a moment compare the farm with the factory, noting the changes that have occurred and a partial list of those things that are yet to be done.

The farm home and the farm plant are still one and the same institution to a very large extent. There are a few people who live away from the farms they operate, but generally speaking there is no division between the farm and the farm home. Only recently, in talking with one of our industrial giants, who knows every detail of capital, overhead and operating costs of his factory, I learned that he considers his expensive and overbuilt farm buildings a part of his land and not as an unproductive overhead.

He takes his living and the living of his tenants and farm labor off the farm without giving the farm credit for each production. Yet he pays his factory full price for each little repair that one of the company mechanics at the factory performs on his automobile. He charges the night watchman for the rent of a small cottage located on the factory property and makes a suitable charge for heat and light from the factory's power plant. Nevertheless his farm laborers get free rent and a large part of their living, including feed for a cow, a place for chickens and all firewood from the farm with no credit back to the farm or accounting of any kind.

His palatial home is regarded as a part of the farm. As a matter of fact, it is just as much a part of the factory as it is of the farm and was located where it is simply because the farm offered a more attractive building site than was available in the city.

He can tell to a cent what each factory product costs and which employees work on each job and how much of each man's time is chargeable to each operation. Still at this farm he has no time sheet, no cost sheet, no record of overhead, no feed record; he does not know the cost of a bushel or acre of corn or wheat or oats. He does not make any allowance for depreciations; he does not show an earnings statement or a balance sheet, although he has an accountant whom he uses to study farm costs and farm management and whose time is taken up largely in making estimates of costs and in seeking out better farm practices.

The American farm is largely a place to live, and there has been little effort to operate much of our land on any other basis than as a homestead.

But the farm has value. It has been and is being used as security. The farm requires seasonal capital as well as permanent capital investment. The bankers' money is invested in the industry. The farm organizations are clamoring for the profits with which to pay interest and principal. The sales value is no longer the sole consideration for a farm loan. The profit factor is a definite part of our agricultural problem, as it became a part of the industrial plant a century ago. Capital must be paid, and it must be paid from profits, and profits are derived only from an efficiency of operation that is better than the average.

The man of agriculture if he is to have a margin of profit, must know the separate items of the cost of doing business. He must know the cost of carrying the investment, the cost of preparing the seedbed, the cost of planting, the cost of seed, the cost of raising the crop, the cost of harvesting, the value of good seed. He should understand the value of plant food, whether in the form of ingredients in the soil or in the value of fertilizer purchased to replace that which has been extracted by the crop, the cost of machine expense, the cost of man labor, and the cost of power whether it is measured in feed consumed by horses or as a cash outlay for mechanical power.

He must know all of these things and many more measured in terms of the product produced. He must know the point of maximum efficiency for each and every item. He must know the economy of spending money to increase returns and abandon the only economy known to agriculture for centuries; namely, "go without." If agriculture is to prosper it must know and avoid the high cost of inefficiency. It must measure prosperity in terms of profit and not in terms of high prices.

When we consider that the variation in the cost of performing different operations in agriculture vary as much as five to one on farms which are supposed to be in the same class, the variation in the price of the product sold is of rather minor importance.

Let me give you an illustration that is perhaps familiar to most of you. Taking 1923 figures on corn production in Marshall and Shelby counties, Iowa, the cost of producing a bushel of corn varied from less than 15 cents to more than 75 cents. It may interest you to know that the farm that produced corn for 71 cents is as rich and would carry as large a loan as the one that produced corn for 13 cents. It so happened that the man whose corn cost 71 cents was a good

Just as the adoption of the electric motor and central station power has worked a secondary revolution in industry, so does the application of abundant electric power promise a large part in the industrializing of agriculture. Here the motor driving the thresher is supplied from a portable step-down transformer set connected to a power line branch

stock man and that he fed it with high efficiency and on the whole operation made some money, but the man who produced corn for 13 cents was also a good stock man and fed his corn with enough efficiency to reduce his mortgage greatly.

But stock breeding is not agriculture; it is animal husbandry and follows a set of laws completely different from those for producing the crop. The variation in the cost of producing stock ready for the feeding pen is as great as is the variation in the production of corn. Let us assume the stock is raised and ready for fattening. To be a successful feeder a farmer must know types and quality and breeds of stock; he must know the value of feeds and the best methods of feeding. The feeder is a manufacturer pure and simple. The laws of feeding livestock follow the same fixed laws of efficiency and much in the same proportion as the manufacturing of power through the conversion of coal into kilowatt-hours, through the medium of a boiler and engine and electric generator.

The variation in the efficiency with which pork is produced through the feeding of corn to hogs is as great as that of producing corn. Taking 1922, 1923 and 1924 figures on corn fed to hogs in Humboldt county, Iowa, the variation is from less than 5 bushels of corn per hundred pounds of pork to more than 13 bushels.

An analysis of any of the various farm operations will show as great variations as the two illustrations given above. Farm cows vary from 5 pounds of butterfat per year to more than 300 pounds. Chickens by flocks vary from less than 30 eggs per hen per year to more than 125 eggs. Only last summer I observed a variation in the number of bushels of corn produced per worker of from 1500 bushels to approximately 8500 bushels.

Only a superficial analysis points to some very vital factors in efficiency that influence cost, and each factor has a corresponding factor in industry, a factor that is similar in nature and effect. Let me state a few examples.

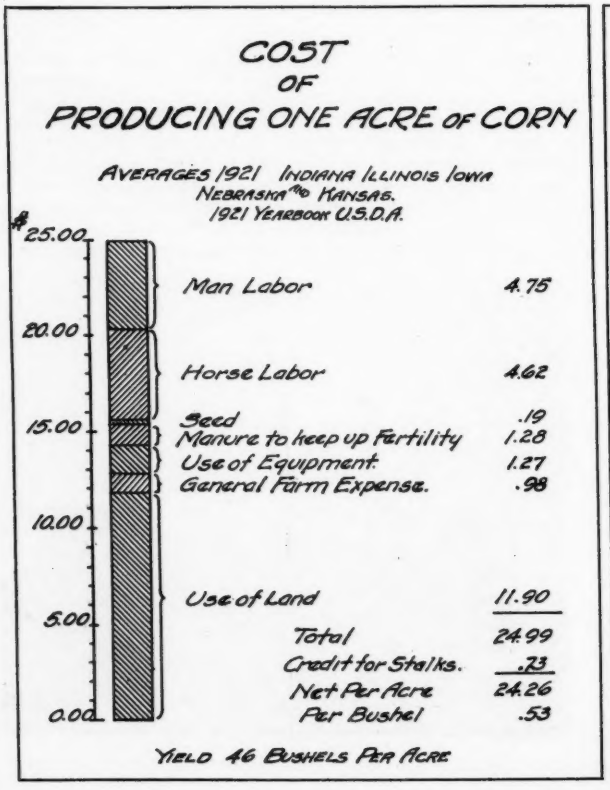
The first great step in the industrial revolution was to increase the output per worker. This was accomplished by the use of power and machinery. Power and machinery greatly influence output per worker in agriculture.

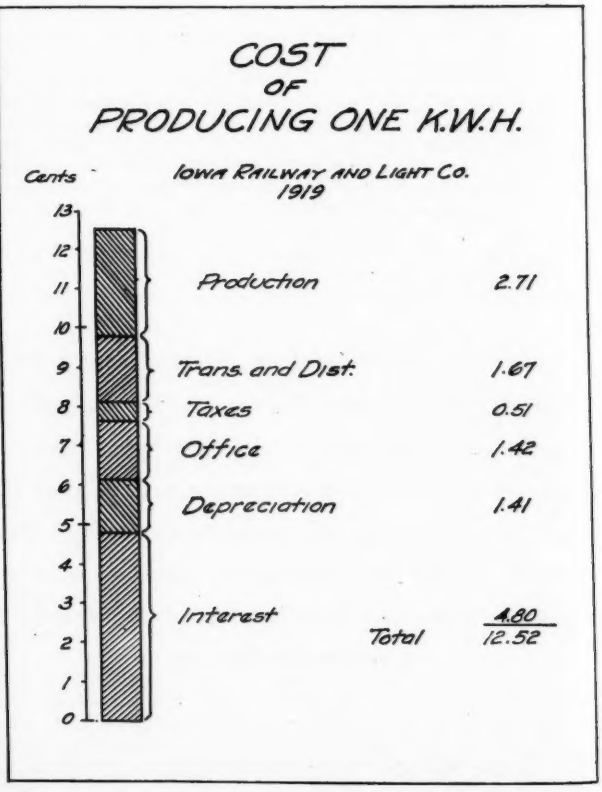
The efficiency of the use of both power and equipment increases with the output. In industry the preeminence of any nation or company is measured in terms of mechanical power equipment, other things being equal. Similarly, preeminence of any nation or individual in agriculture is measured in terms of power and machinery, efficiently used. In both instances he that produces the greatest quantity per worker per machine has the lowest production cost.

Let me illustrate by one of the accompanying charts. The cost of raising an acre of corn was compiled from the United States census. The cost of producing a kilowatt-hour was taken from one of the most prominent rate cases tried during the last decade and shows the costs of delivering a kilowatt-hour of electricity to a small town located at some distance from the power house on a transmission line.

Let us analyze the charts with the view of increasing the efficiency and reducing the cost of production. In the case of the acre of corn, more than 75 per cent of the costs are fixed charges, and independent of the farm operation. In the case of the electricity about 50 per cent of the costs are fixed. The rate case that called for the development of this cost chart was tried in the federal court, the utility claiming that a rate which produced only about 10.15 cents per kilowatt-hour was confiscatory. The court ruled that any rate that produced less than the costs shown in the chart would be confiscatory. An engineering cost analysis showed that at the time these costs were figured the per capita consumption per year was 62 kilowatt-hours and that a reduction of costs per kilowatt-hour could be more easily secured through an increased use of current than from any other cause. A sales campaign increased the consumption to 88 kilowatt-hours per year in 1923 with a current cost of 9.07 cents per kilowatt-hour and a consumption of 128 kilowatt-hours in 1924 produced a cost of 6.37 cents, which made it necessary to reduce rates to stay within reasonable earnings.

Applying the same methods to the acre of corn, a yield of 60 bushels will show a cost of about 40.43 cents and 80





bushels a cost of about 30.32 cents of which nearly half is for the use of the land.

Large production calls for an efficient sales organization, a new factor in agriculture, and again let us look to the factory to find an analogous situation. The home factory waited for people who wanted its product to come and buy, but mass production made it necessary not only to take the product to market but to create new markets.

Agriculture with all of its age and development has no sales organization worthy of the name. If it has a surplus it does not even take it to the market; it simply puts it on the cars and lets it drift to a market through whatever channel it happens to get into and takes as full payment what happens to come back. The farm as a factory must have better selling facilities, if agriculture is to equal industry.

You may ask how the farmer with his 6,449,343 American competitors, not to mention a few odd million in other countries, is going to place his business on a plane with the manufacturer—if he is going to attain the high standard of business efficiency that will elevate agriculture to a level as a business with modern manufacturing industries.

There never in the past has been an industry that commanded the attention of so many powerful factors as does agriculture at the present time. There never was an industry whose basic importance was so fully appreciated and at the same time so little understood.

Agriculture has never been analyzed; it has never been broken up into its component parts. It has never been vitally necessary to know whether the profit or loss came from a farming operation or from a feeding operation. It has never been necessary to have a profit above living expenses as there was little interest to be paid and the foreclosures were so few that there were always purchasers enough to absorb all of the offerings. Many times loans were made by unscrupulous bankers with the view of eventually acquiring the property.

Let me digress for just a moment to call attention to the fact that much of the relief to agriculture must come through the banks and insurance companies now holding farm securities in large blocks, and this relief will not come through better credit or more liberal loans. It will come through two sources, one from reforms within the industry of banking and the other through helping to analyze the industry of farming and helping agriculture to apply new and better practices.

The banker, as such, should be in the business of handling money as a commodity and not in the business of handling the money of the depositors for his own or his friends' benefit. The real banker can confer no greater benefit to agriculture, and I might include all businesses, than to drive out of the banking business all that class of men who are in the business for the purpose of handling the depositors' money in ventures of their own. He can help raise up a race of bankers who will finance agriculture as other businesses are financed, on a basis of earnings and not on a basis of selling out the farm when the security ceases to appreciate in value. One of agriculture's greatest financial troubles today, and I might say one of our greatest banking troubles, is the result of men whose only ability as bankers comes from being able either to purchase a block of stock or to organize a bank, placing loans on the speculative value rather than on the earning value of the land.

On the other hand, the banker has entered the field of agriculture and his interest is not that of the banker of a generation ago, namely, to acquire eventually a valuable piece of property at a low figure. His interest is a security that has a value based on regular and stable earning, one that will pay a return on his part of the investment from earnings. Some of the leaders in agriculture have been clamoring for a profit in the industry; some of our would-be-politician farm leaders have been trying to legislate a profit rather than earn one. The press, both the newspapers and farm papers, have been demanding a profit in their play for both subscriptions and advertising patronage. But the person who must in his own self-defense place a profit in agriculture is the banker, the big insurance company, the mortgage investor, taken collectively under the general name of capital.

But how will this profit factor be introduced? It will come from more efficient farm practices. It will come from a better knowledge of just what is agriculture and what is animal husbandry and what is manufacturing and what is business management; better knowledge not only on the part of the farmer but also on the part of the banker. Imagine the largest industry in the world without a cost sheet or an earnings statement or a balance sheet or an efficiency system or a knowledge of the various types of investment within the industry or a sales organization!

I will admit the U. S. Department of Agriculture and our experiment stations have done much and have gathered much valuable data, but little has been done to utilize it and most of what has been gathered is in terms of averages and not in terms of the best practices. Much is being done to gather crop and market reports that are of value but much of it gets to agriculture too late for practical use. More work should be done along lines of surveying and analyzing with a view to forecasting markets to ascertain what they will absorb. Much can be done to locate a market for our surplus, at a profit, rather than to create machinery to dump it to the benefit of our competitors abroad.

The great cooperative movement of agriculture must be utilized to fit it into its proper place with other industries and not to antagonize those businesses which are its natural allies. This great movement should be directed towards economy of production through utilizing efficiently the machinery of its allies with as much zeal as it utilizes its own machinery. Let me illustrate by asking the question, "Will agriculture derive the most benefit by utilizing to the maximum capacity our present transportation systems or from creating new systems none of which can be used efficiently?" Allow me to suggest that the banker of both industries, namely, the insurance companies, the trust companies, and the million small investors, call the two industries together to solve their problems, rather than permitting them to be made political footballs by men who must have some issue with which to get themselves elected to office. The farm interests of the country and the National Electric Light Association are using this method of solving their problems through the Committee on the Relation of Electricity to Agriculture. I commend the plan to anyone who has a problem to solve with agriculture.

The industry of agriculture must be analyzed; it must be made efficient; it must be placed in a position to know whether it is expensive operating costs in producing the crop or poor manufacturing practices or poor sales methods or poor banking, or excessive overhead that is causing the loss.

Those interested in agricultural securities are entitled to a return based on profits earned and should have a better standard for measuring values than speculative appraised value, or actual sales where the sale is made on any other basis than an earnings record.

The people who consume agricultural products are entitled to know that their food supply is permanent and on a sound economic basis.

Business generally should be guaranteed against the hazard of depression in our greatest basic industry and against depression in the ranks of the greatest purchaser of the output of all industries.

I am reliably informed that the next president of the American Bankers Association is much interested in this analysis of agriculture and is willing to join hands with other interested parties to make this analysis. The farm leaders who are really competent to lead and direct agriculture are interested and will lend a helping hand. The agricultural press knows that the present method of handling the situation is not producing results. The politician has failed and is ready to drop "farm relief" for a "tariff fight." Government agents are ready to go to work on their part of the program. The manufacturers, transportation companies, labor and the consuming public are ready to cooperate.

Mr. President and members of the American Society of Agricultural Engineers, a society representing the best analytical minds in agriculture, allow me to suggest that one of the main objectives of the Society for next year be a thorough comprehensive analysis of agriculture as an industry.

Lighting of laying houses promises a worthwhile contribution to the farm electrification program. It adds to the total energy consumption, the load is desirable in character, and in the case of morning light, at least, comes at a desirable point in the load-time curve. Pullet lighting gives a large and easily demonstrable profit, in relation both to equipment investment and energy costs, hence affords an excellent avenue of sale appeal.

Results from Artificial Lighting of Laying Houses*

By Geo. W. Kable

Mem. A.S.A.E. Agricultural Engineer, Oregon Agricultural Experiment Station

A BOOK published in 1920 by the Reliable Poultry Journal Publishing Company, entitled "Use of Artificial Light to Increase Winter Egg Production," gives the history of poultry lighting and lighting investigations insofar as it is known. The publication includes articles by many prominent poultrymen and a series of ten colored charts giving results of illumination studies at Cornell University over twelve-month periods. Another source of some interesting results on the artificial lighting of poultry houses is the November, 1925, issue of the British Journal of the Ministry of Agriculture. In this article E. T. Brown gives costs and profits from lighting along the figures on annual production and effect on grades of eggs.

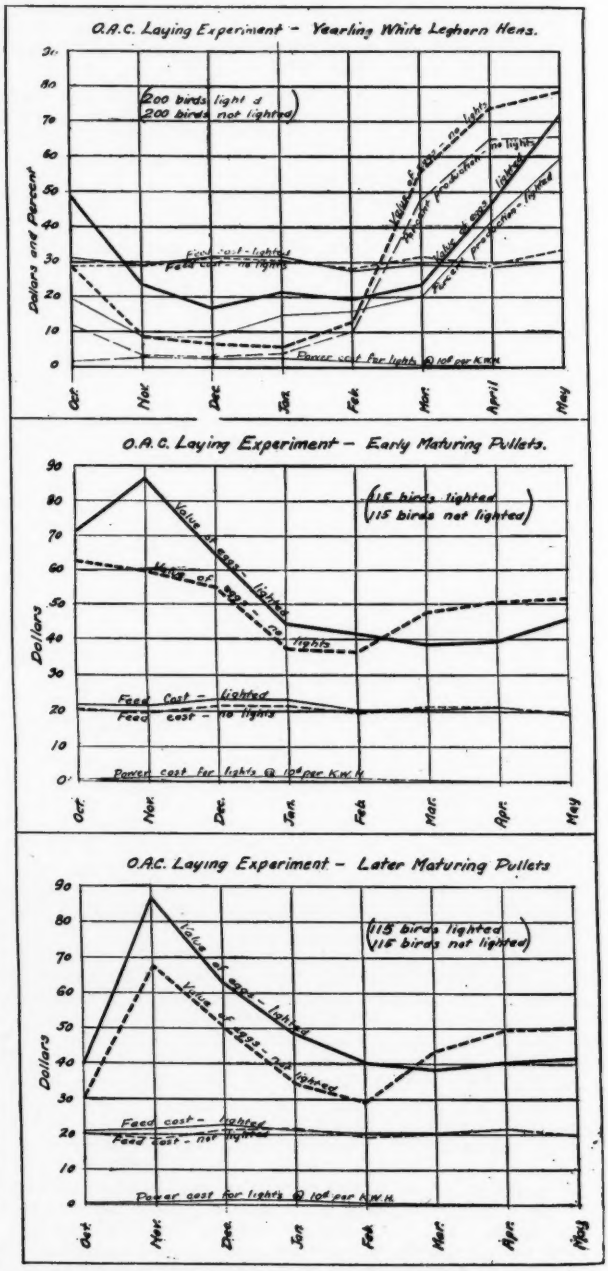
A lighting test was started by the Oregon agricultural experiment station in October 1925 on yearling hens, and on pullets, segregated according to vigor and the time of reaching maturity. Our results for the first eight months are similar to those reported in the publications cited above.

The past winter has been unfavorable to benefits from lighting, due to the mild weather and the accompanying low price of eggs. In spite of this condition and the further fact that our yearling hens went into the test in poor physical condition, each lighted pen produced a worthwhile profit over its unlighted neighbor from October to February, inclusive. The lights were still on in March, but the days were long enough so that unlighted pens which had been having more or less of a vacation came back strong, and outlayed and outprofited the lighted birds. This being the natural flush season for eggs, all of the pens were well up in production. Lights were discontinued April 1.

It is noticeable that the feed-cost curve follows the general shape of the production curve closely. The hens that lay most, eat most. The feed-cost curves, however, are never separated very far, showing that the difference in the cost of feed is relatively very small in comparison with the difference in the value of the eggs produced. The lighting cost curves, with power figured at 10 cents per kilowatt-hour, remain very close to the base line of our charts. The cost per bird per month could always be paid for with half an egg. The mortality in our pens of lighted birds has been slightly higher than in the unlighted, but the mortality in all pens was below the normal average.

The feasibility of lighting pens can be determined very closely by comparing the areas included between the "value of eggs" curves for the lighted and unlighted pens. These curves crossed in March in our test. They are again converging so that we can make a reasonably close estimate of the areas for the year. It appears this year that the lighted pens will still have the advantage after the summer layers have had their inning. If such is the case, a cold winter with high egg prices should result in a very acceptable profit. Our tests are to be continued.

The general conclusion from both experiment station tests and commercial experience is that lighting intelligently applied has the effect of smoothing out the production curve, taking enough eggs from low-price seasons to those of high price to pay all costs and yield a handsome profit; in fact, to augment materially the total profits of the enterprise.



Curves showing comparative results from egg production tests at the Oregon station with and without artificial lighting

*Discussion of a paper, entitled "Poultry Conditions on the Farm as Affected by Electricity," by E. A. Stewart, presented at the 20th annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, California, June, 1926.

Control of the Corn Borer by Machinery*

By C. O. Reed

Mem. A.S.A.E. Professor of Agricultural Engineering, Ohio State University

THERE are two general areas in the United States in which the European corn borer has become well established. The Eastern infestation covers parts of eastern New York and some sections of the New England states. In this area the borer passes two life cycles per year. The western infestation, with which this paper deals, has occurred since 1921 and covers sections of western New York, western Pennsylvania, northern Ohio and eastern Michigan. In this section the borer has only one life cycle a year. The reasons for the difference in the habits of the insect between the two regions are not known, but it is to be noted that, if the development of two life cycles a year should appear in the Central West or South, the control problem, and the machinery for that control, will be subject to material modification.

One main kind of control activity is the quarantine of infested areas to prevent the transportation of infested material into uninfested territory. Valuable and seemingly effective as the quarantine measures have been, they cannot check the natural advance of the borer through flight of the moths, nor does the quarantine afford any measure of relief within the infested areas. The other type of control consists of methods to keep the borer population in check where it is already established, the aim being to keep the infestation below the point where appreciable commercial damage occurs. The more important methods which have been tried or studied are parasitic control through the introduction of natural enemies, the use of insecticides, plant breeding, special schemes of crop rotation and mechanical destruction of the borer itself. None of the first four has yet been sufficiently perfected to permit general application and even the most promising of them will require such a length of time as to prevent its meeting the situation in any adequate way. The remaining method, mechanical control, which must be relied on at least for the immediate future years, involves personal violence to the insect in the borer, i. e., the larval, stage, and this may consist of destruction by heating, by plowing under, although this is not a particularly promising method, or by mechanical reduction of all crop remnants to such a degree of fineness as to insure reasonably complete destruction of all the borers contained therein. It is pointed out that the development of appropriate machinery is essential, not only to make the job physically possible, but to permit it being done at a cost not economically prohibitive, furthermore to enlist the support of the American farmer who simply will not employ laborious hand methods.

Although the borer sometimes takes refuge in other plants, it chiefly lives on and in the corn plant. It passes the winter as a full grown larva or caterpillar close to an inch in length. It hibernates in the stalk, stubble, or cob, regardless of whether this trash is standing, lying on the surface of the ground, or slightly buried. These caterpillars can live for many days in fresh or salt water, in cow or hog manure, and in the liquid therefrom. It also withstands considerable pressure, such as from being rolled between the fingers, but it is killed quickly by slight puncture of the skin, and it is readily susceptible to heat, such that the heating of horse manure and of ensiled corn are fatal to it.

With the coming of warm weather in the spring the caterpillars continue their feeding until early in June, at which time, still in the old crop residues, they go into the pupal or dormant stage of the life cycle, emerging in some ten days as moths. After mating the females lay their eggs, about three hundred, on the under side of the leaves of young corn. These eggs hatch in five or six days and for a few days the tiny borers may feed on the surface but soon bore into the interior of the stalk, continuing to grow from early in July until the arrival of cooler weather, at which time the caterpillars begin to work downward in the stalk.

As it is in this point of the life cycle that the only practicable control measures can be applied, and because the position of the borers in the stalk is a vital point in the mechanical problems, this downward movement in the stalk is of extreme importance. Stubble 18 inches high, cut on September 10 shows less than 23 per cent of the total borer population, more than 35 per cent on October 1, and more than 66 per cent on November 3. For stubble cut three inches above the ground on the same dates the percentages of borers remaining are 2.9, 4.0 and 10.0.

One of the earliest implements used in borer control was a homemade stubble shaver (Fig. 1) designed to cut off, close to the ground, the stubble, one or two feet high, left by the ordinary corn binder. This device, consisting of a V-shaped sled with sharp blades along the diverging sides, shaved off two rows of stubble with about 5 per cent effectiveness. Following this device a sulky rake is employed to rake the recut stubble into windrows and piles for burning. Rakes as ordinarily built have the teeth too far apart and on rough ground they seem to jump over the trash. Rakes with closer spacing and stiffer teeth have been furnished for this purpose, but at best the results secured from stubble shaving and raking are not adequate unless supplemented by a prohibitive amount of hand labor. The degree of thoroughness essential to satisfactory control is difficult to appreciate, as only a little untreated trash on the surface will harbor an amazing number of caterpillars. The field shown in Fig. 2, which would ordinarily pass for clean ground, in May,

*Abstract of paper presented at the 20th annual meeting of the A.S.A.E., at Lake Tahoe, Cal., June, 1926. Paper published complete in 1926 A.S.A.E. Trans.

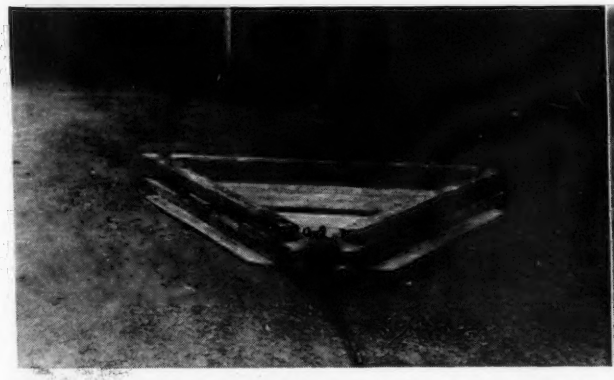


Fig. 1. (Left) A homemade stubble shaver. Fig. 2. (Right) On the surface of this seemingly clean field nearly 10,000 healthy larvae await the next corn crop

1926, had more than 27 per cent of the preceding year's total borer population in healthy condition on the surface of the ground, an amount sufficient to increase the infestation sixfold. So important is the elimination of even small amounts of untreated trash on the surface that government and state control authorities have found it necessary in many cases to resort to hand raking in fields where the residues have been horse raked and burned in windrows. This supplementary hand raking takes about one day's labor per acre. It is to be noted that the borers find refuge not only in unmutilated short pieces of stalk, but also in curled up portions of dead leaves and husks, and at the base of husks, particularly when such parts lie on the ground and are damp.

With a view to accomplishing in a more effective economical way the work done by shaving, raking, burning and hand picking, the International Harvester Company has built a stubble shredder (Fig. 3), a two-row machine with shredding heads of a construction similar to that of a swinging hammer type of feed mill. The beaters are raised and lowered by a lever, while the power for driving them is supplied by a power take-off on the tractor. It has been used with tractors of 10-20 and 15-30 horsepower rating, the latter being more satisfactory. A machine of this sort, to be completely effective, should also take care of scattered corn remnants lying between the rows. Prior to the development of the stubble shredder the department of agricultural engineering at the Ohio State University and the same company had been experimenting with a potato digger to remove and load corn stubble. It was effective in removing the stubble and root and in cleaning them to some extent, but the method is subject to the objection that the stubble must be collected and burned, involving additional operations and cost.

In view of the fact that very few borers are found in the corn plant at or below the surface of the ground it is assured that an adequate measure of control can be secured if the stalks are cut within an inch of the ground and the stalks so cut given proper subsequent treatment. This led to a demand for a low-cutting attachment for corn binders. This job being delegated to the Ohio State University agricultural engineering department, experimental work was done on four different types of low-cutting device. The problem was difficult, due to complications presented by soil, stones, and particularly weeds. Two types of low-cutting attachment were developed to a satisfactory point, one employing a reciprocating knife and the other a disk cutter. Manufacturers were then asked to commercialize these low-cutting attachments for their own machines, and this has been done by Deere & Company, the International Harvester Company and the Moline Implement Company, with the Massey-Harris Company soon to follow.

Owing to the fact that it is not possible to guide a corn binder with perfect accuracy, and the further fact that close cutting cannot be done if the stalks are bent sidewise before being cut, it was necessary, in designing the reciprocating knife machine (Figs. 4 and 5), to increase the throat width from four to eight inches, necessitating two knife sections and a stub guard. Similarly it was necessary to speed up the knife so that the cutting depth of the knife per stroke is greater than the distance that the machine moves forward during that stroke, plus an additional amount to allow for bullwheel slippage, ten per cent being suggested for the latter item. As built the device is rigid on the frame instead of floating, consequently if often works at or below the surface of the ground, making it useless to attempt keeping the knife sharp. Instead, it is made very heavy and care taken to keep the sections working close to the ledger plates. Furthermore to facilitate snapping stones ahead instead of binding them between the sections and ledger plates, the included angle between these parts, or the shearing angle, was increased to 49 degrees. No objections have been found to this change in cutting angle.

It was found that this type of cutter required more power than could be taken from the bullwheel under all condtions, and a four-horsepower binder engine was employed in the usual manner. With this type of cutting mechanism, employing a sufficiently high knife speed, it is not necessary that the stalks be stiff enough to hold themselves while being cut, consequently it is equally well adapted for work in either green or dry material.

Experiments were made with a disk cutter having one cutting blade is connection with two, and later one, notched feeding disks. The cutting disk turned about one-third faster than the feeding disks, and both rotated so as to draw the stalks and trash between them. Owing to the restricted cutting area, which necessitated an impractical degree of accuracy in guiding, and because of clogging with trash, this design was unsuccessful, as was also using the same arrangement of cutting blade working against a stationary plate.

The third and successful type of disk cutter (Fig. 6) employs a disk rotating in the opposite direction, avoiding the difficulty from trash and trouble from stones, and also increasing the cutting action without increase of rotative speed. A deflector, shown at A in Fig. 6, increases the width of the cutting space into which the stalks must come. As built the disk makes sixteen revolutions to one of the bullwheel, but a somewhat higher speed is deemed preferable. With suitable lug equipment adequate power for this device was secured from the bullwheel. With the disk cutter its effectiveness depends on the stalk holding itself against the cutting edge, consequently it works better when the stalk is still green.

After the stalks are cut close to the ground and removed from the field there remains the problem of making sure that all or practically all of the larvae therein will be destroyed. Such stalks may be fed whole and the residue carefully segregated and burned in the spring prior to the emergence of the larvae. A more practical and effective procedure is to shred the stalks, leaves, husks, etc., prior to feeding. Preliminary data, taken from experiments not fully completed when this paper was prepared, involving careful observations with both the cutting and shredding types of husker-shredder, indicate that the borer mortality, computed early the following spring to take account of deaths following injuries, ranges from 95 to 100 per cent. Although in these experiments the cutter head or combination cutting and shredding head type of machine seems to have a slight advantage, the number of experiments was too small to make the slight difference conclusive. It is urged that shredding machines be operated with enough tension on the snapping rolls to make sure that the stalks will be squeezed tightly while passing through, as a large percentage of the borers are thus killed. It also is important that all loose grain and other material which falls through the screen and through the ear corn chute be destroyed or fed to poultry as soon as possible, as this material contains many loose borers. Owing to an unexpectedly high mortality in the case of one machine in which cutting was not shorter than two inches, the question is raised as to whether a considerable part of the killing is done in the blower fan.

Fig. 3. A new corn borer implement, the stubble shredder

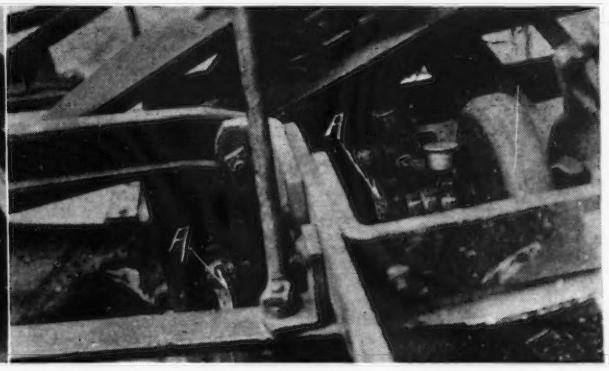


Fig. 4. (Left) The Ohio State University machine equipped with a reciprocating knife type of low-cutting mechanism. Fig. 5. (Right) Walking beam construction used to avoid the necessity of changing the position of the pitman shaft and balance wheel

Ensiling is regarded as a thoroughly satisfactory means of borer control. It appears that such borers as escape destruction by the knives and blower of the silage cutter are killed by either the heating or fermenting of the silage.

To meet the situation presented by sweet corn fields from which the ears have been removed, a Ronning field silage cutter was modified by equipping it with a disk type of low-cutting mechanism and by reducing the speed of the feeding mechanism so that the material was cut into one-half inch lengths. The cut material was spread on the ground. The operation of this machine was satisfactory.

For the emergency treatment of infested fields which must be cleaned up by the intervention of governmental agencies burning machines are employed, one of these outfits being shown in Fig. 7. The tank truck carrying a supply of fuel oil is parked in a road or lane at the side of the field and the oil forced under high pressure through a long hose to the burning carriage which is hauled by two men. It has a nozzle beam from which a sheet of flame about eleven feet wide is thrown down onto the crop residues, subjecting them to a temperature of about 1400 degrees for approximately one second, this being enough to light dry leaves and husks, to slightly char the stalks and kill any hiding larvae. The method is highly effective, but the operating cost is about $12.00 an acre exclusive of overhead charges on the investment of approximately $9,200.00.

Attempt has been made to destroy borers by crushing stalks between two large corrugated rollers. Notwithstanding that extremely high pressures were employed the destruction of borers was not nearly complete enough and the method has been abandoned.

Although plowing under of crop residues is an effective method in the New England infestation, it has not proved effective in the western area, as many borers crawl to the surface when buried a foot deep. Regardless of whether plowing is done in the fall or spring a dangerous percentage of the buried larvae appears sooner or later at the surface. If here exposed they fall prey to beetles, ants and especially birds. On reaching the surface the borer immediately seeks shelter in trash or vegetation of some kind, crawling at least 25 feet in search thereof.

It is concluded therefore that if any trash whatever appears, even after weathering or harrowing, plowing is a miserable failure as a control measure. Aside from the headlands and fence rows to which the borers may escape, the most dangerous feature of plowing as a control measure is the average plowman's idea of what constitutes clean plowing. Best results have been secured with wide bottoms and with those of easy rather than of bluff turn. Work has been done on a trash attachment for use on the common sizes and types of plows now in use, the purpose being to lay the trash well under the slice, even though this is contrary to what is considered good soils practice. Work thus far has been devoted to experiments with floating strap iron fingers shaped in conformity with the surface of the turning slice, holding the trash there and preventing the usual pitching of trash.

Anticipating the situation to be met when the corn borer reaches the corn belt proper, where 95 per cent of the corn is either hogged-off or picked from the standing stalk, the Ohio State University agricultural engineering department has made a rather extended study and analysis of the problem, taking into account the well-established requirements which must be met, together with the ability and inclination of the corn belt farmer to employ various expedients. It is taken as a premise that he will accept and use mechanical methods but probably will rebel at laborious hand methods or work of a peasant type. Eleven possible methods were considered, divided into two general classes, the first four necessitating successive operation with equipment now in general use supplemented by a considerable amount of hand work; the next six methods being of the "once-over" variety doing the complete job at one operation with special machinery and without any supplementary hand work, and the eleventh a modified non-corn-belt method. The methods are as follows:

1. Corn hand picked; stalks broken by rail, raked and burned; remaining trash in field hand raked or picked up.

2. Corn hand picked; stalks cut with mower, raked and burned; remaining trash in field hand raked or picked up.

3. Corn picked with present-day machine picker; stalks broken by rail, raked and burned; remaining trash in field hand raked or picked up.

4. Corn picked with present-day machine picker; stalks cut with mower, raked and burned; remaining trash in field hand raked or picked up.

5. Corn picked and stalks shredded by proposed harvester No. 1 hauled by 15-30 tractor. This harvester No. 1 is the single-row present day picker to which a shredder head has been attached. The machine picks, husks and loads the ears into the ear wagon. It cuts the stalks with a low-cutting attachment, then shreds the stalks and husks, and spreads the shredded material over the ground or lays it in windrows or in piles in case the stover is wanted for feed for stock to be turned into the field later. The tractor in this method hauls the harvester and drives its parts, but because of power limitations the ear wagon must be hauled alongside the harvester by an extra team. Estimated cost of harvester No. 1, $800.00.

6. Corn picked and stalks shredded by proposed harvester No. 2 hauled by 10-20 tractor. This harvester No. 2 is the same as No. 1 except that it carries its own motor. In other words, harvester No. 2 is a single-row corn picker to which a shredder head has been attached ,all harvester parts driven by a 20-horsepower motor mounted on the harvester. This permits a smaller tractor to haul the outfit. The ear wagon is also hauled by the tractor. Estimated cost of harvester No. 2, $1200. This method considers the harvester individually owned.

The sharpest challenge and the greatest emergency ever confronting the agricultural engineer are presented in the corn borer. If the meeting of this challenge is carried through as it has been begun, the standing of our profession among the branches of engineering and its vital importance to the success and profit of agriculture can nevermore be questioned. The confidence with which the burden is placed on our shoulders must be justified.

7. Same as method 6 except the harvester (2) is owned and used cooperatively by three corn growers.

8. Corn picked and stalks shredded by proposed harvester No. 3 hauled by 15-30 tractor. This harvester No. 3 is a two-row machine which picks, husks, and loads the ears; it also shreds the stalks and husks and spreads the stover over the surface or lays it in windrows or in piles. It carries its own 30-horsepower motor. Estimated cost of harvester No. 3, $1700. This method considers the harvester individually owned.

9. Same as method 8 except the harvester (No. 3) is owned and used cooperatively by three corn growers.

10. Corn picked and stalks shredded by proposed harvester No. 4. This harvester No. 4 is a two-row, self-propelled machine equipped with crawler treads. It picks the corn and shreds the stalks similar to the other harvesters. Being a large costly unit, this method considers that the harvester is owned and operated by a custom operator who serves a community and charges by the acre. Estimated cost of harvester No. 4, $3800. (For Indiana and Ohio conditions such a machine might be equipped with a stover loader to permit the shredded stover to be hauled to the barn and blown into the mow for feeding; it might also be arranged to substitute a cutter head for the shredder head so that the machine could also be used to handle silage corn as the present field ensilage cutters do.)

11. Corn cut with corn binder equipped with low-cutting attachment. Corn shocked, hauled to barn and husked and shredded by husker-shredder.

Space will not permit enumeration here of the conditions assumed and the cost basis used nor the details of the cost computations, although these are in the complete paper condensed from a 65-page report of the Ohio State University. It may be said that the size of farm contemplated is 200 acres, one hundred acres in corn except in methods 7, 9 and 11 in which 80 acres of corn is assumed. The various elements of cost are included with a high degree of completeness. The life assigned to the special harvesters is seven years except for No. 4 which is credited with six years.

The cost figures as computed include all costs of harvesting the ears from the standing stalk to the crib and of handling the remnants as described. The costs were computed for both a 40-bushel yield and a 60-bushel yield per acre. In general, the acre costs are slightly higher and the bushel costs are materially lower on the 60-bushel than on the 40-bushel basis. It may be noted that on both the 40 and 60-bushel basis. the most costly of the once-over methods is materially less than the most economical of the methods employing present-day equipment. The cost figures per acre are as follows, the method number being followed first by the figure for a 40-bushel yield and then by that for a 60-bushel yield: Method 1, $7.11, $8.68; Method 2, $7.54, $9.11; Method 3, $7.23, $7.44; Method 4, $7.71, $7.87; Method 5, $5.31, $5.47; Method 6, $5.40, $5.55; Method 7, $4.42, $4.57; Method 8, $5.63, $6.13; Method 9, $4.29, $4.79; Method 10, $5.08, $5.80; Method 11, $9.66, $12.02.

From this Ohio State University study of comparative costs of possible and proposed methods of harvesting, the following inferences may be drawn:

1. By machinery, which simply combines machine elements now used in independent operations, the corn borer can be effectively controlled (in areas where it has been the practice to leave stalks standing) without a material increase in cost of harvesting over present methods, and with a materially lesser cost than if present methods are used followed by the old stalk burning process.

2. Regardless of cost differences within reasonable limits, the corn-belt farmer will be inclined to engage in control by machinery methods much more whole-heartedly than he will in control which involves hand methods.

3. Although some of the proposed two-row harvesters compare very favorably in cost of operation with the one-row outfits, the higher initial cost of the former will handicap their introduction. The smaller machines, even at a slightly higher cost of operation, will have a much better chance for wider adoption.

4. If these suggestions regarding the proposed harvesters have merit from the standpoint of the typical corn-belt states, it is none too early to begin development work on the machine or machines which have the most promise. Three or four seasons of development work will probably be necessary before any manufacturer could safely enter upon a production program.

It is to be noted in connection with the "once-over" methods by the proposed new harvesting machines no credit is given for preserving the crop residue from the standpoint of soil fertility and tilth.

Another point worthy of consideration, but excluded from the computations described, is the feeding value of shredded fodder laid in windrows or in piles as contemplated by the combination harvester compared with that whole stalks standing in the field as under prevailing corn belt practice.

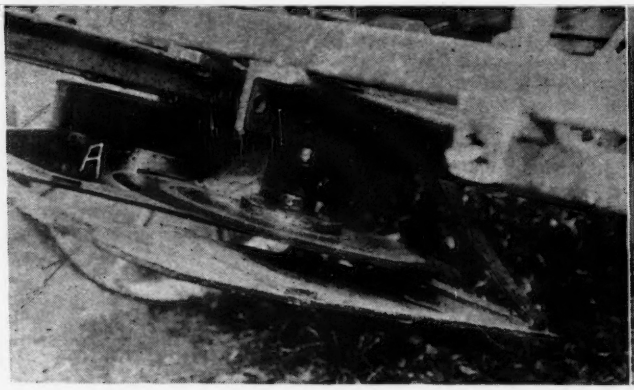


Fig. 6. (Left) The disk type of low-cutting mechanism; the frame is shown tilted up. Fig. 7. (Right) A burning machine at work

A Plan for the Reduction of Plumbing Costs in the Farm Home*

By Arthur W. Turner

Assoc. Mem. A.S.A.E. Associate Professor of Agricultural Engineering, Iowa State College

WATER supply and plumbing systems have not come into general use on the farm due to two reasons. The first of these is the farmer's lack of knowledge of plumbing and its value. Neither does he realize that he can partly install a system himself. The second is the local merchant. In most instances the merchant or plumber seems satisfied with the volume of business he has within the town limits. If the farmer approaches him he sees his needs in the light of his urban customers. Thus the plumber's inability to render service to the farmer and his excessive prices through legislation protection have prevented the farmer from becoming a customer for water supply and plumbing.

Farmers and farmers wives want running water. No one doubts that, but realization is the problem. Many have accomplished this. A survey made by one of the leading farm journals of the Middle West is of interest at this point. Before presenting the charts, a word of explanation is advisable. I repeat the statement given in the introduction to the report: "Comparison with government figures shows that farmers, reading this journal, are above the average. For this reason the information obtained from our investigation may be too favorable to permit the figures used to represent all farmers." Actual conditions may not be as bright. Published under date of October 1925, the tables are given as the latest authentic survey of this situation.

It appears that no state has over 30 per cent of the farm homes with running water and only 17 per cent in the entire area. A small additional number have definitely decided to install water systems. Undoubtedly the reasons given before account for the present slow increase in farmers installing water systems. As to the number who have bathrooms, one is gratified to find a still larger percentage than in water systems. This no doubt is due to the fact that many farm homes have a room with a bath tub only. Water is carried to the tub instead of being under pressure. The table reveals, as expected, that the states leading in farming, namely, Nebraska, Kansas, Iowa, Ohio, Illinois, Indiana and South Dakota lead.

*Paper presented at the 20th annual meeting of the A.S.A.E. at Lake Tahoe, Calif., June, 1926.

Table II is given to show the nature of the water systems used. The windmill leads, with the gravity system second. Comparison of Tables I and II reveal that the leading windmill states, Kansas and Nebraska, lead in water systems used.

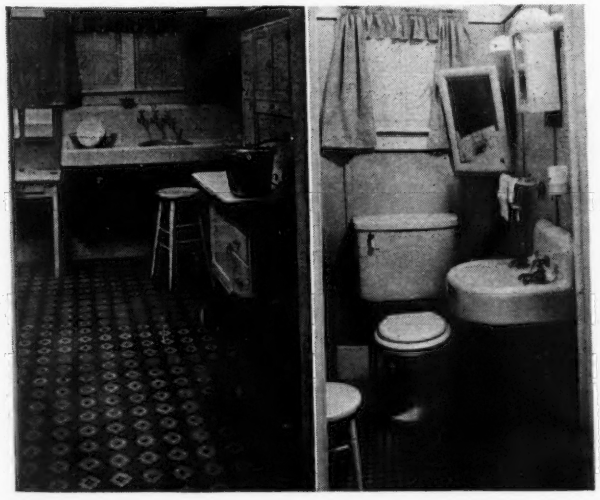
A statement from the paper of William Draper Brinckloe given before the National Farm Homes Conference, sponsored by the A.S.A.E. Farm Structures Division in February of this year, is pertinent here:

"The old jest about the farmer's ignorance of baths is utterly pointless nowadays. Less than two per cent of the plans failed to show a bathroom. But the bathroom was nearly always on the first floor, close to the kitchen. Very excellent reasons were given for this, some of which were that the great majority of farmers cannot afford to install running water. They may or may not put a little suction pump in the bathroom connected to the well; but, in any event, hot water must be carried from the kitchen stove."

It is important that we appreciate the fact that the farmer is somewhat different from the average layman. The farmer is a mechanic, a worker with tools. His natural isolation has instilled within him the fact that he must do for himself. Thus, with native ability, he has latent qualifications to install plumbing.

Specialized education for manufacturer, jobber, local dealer and farmer are essential. The first step is to adopt one common objective for commercial firms and the American Society of Agricultural Engineers. This is being accomplished through cooperative organization. The embryo stage of this work is past and the organizations are progressing rapidly on a unified educational program.

This educational program is divided into two parts. The first is for the local dealer to sell service to the farmer. By that is meant that some one in each business community shall conscientiously study the farmer's conditions and aid him in preparing a practical layout for his individual needs. Resident short-courses conducted by the agricultural engineering departments for farm and rural plumbers seem desirable. At such short-courses many points on water requirements, sanitary aspects of farm supply, differences in farm and suburban plumbing codes could be studied. This would aid



The extent to which modern plumbing has found a foothold on the farm is almost entirely the work of extension workers, both agricultural engineers and home demonstration agents. Having created the demand, it remains to arrange for simplified, standardized, and economical methods of installation. Either the plumbing trade must embrace the opportunity offered it readymade or a new way may be found to supply materials and workmanship really adapted in character and cost, not to urban, but to rural needs and conditions.

Table I. Report of Survey Made in Territory Covering 47 Per Cent of all Natural Farm Income

State	Running water in house —per cent	Having definitely decided to buy —per cent	Have bathrooms —per cent
Illinois	15	4	23
Indiana	19	6	17
Iowa	24	7	28
Kansas	17	5	25
Michigan	25	11	20
Minnesota	13	8	16
Missouri	6	6	13
Nebraska	29	9	31
N. Dakota	10	12	17
Ohio	20	9	17
Oklahoma	11	8	17
S. Dakota	18	7	19
Wisconsin	13	7	18
Total for area	17	7	20

NOTE: This data is taken from 10614 signed statements, results of October 1925. The percentages are based on the reports received.

Table II. Kinds of Water Systems Used by Farmers

States	Per cent Windmill	Per cent Gravity	Per cent Gas Engines	Per cent Electric	Per cent City Pressure	Per cent Other Kinds
Illinois	23	19	27	35	11	
Indiana	38	14	29	21	5	1
Iowa	33	21	23	28	5	1
Kansas	45	15	16	15	12	3
Michigan	55	11	22	10	5	2
Minnesota	23	14	36	23	5	2
Missouri	18	25	25	22	12	4
Nebraska	74	13	7	10	6	2
N. Dakota	17	43	9	30	4	
Ohio	22	34	21	19	11	1
Oklahoma	35	13	6	23	26	
S. Dakota	24	37	15	24	4	2
Wisconsin	31	19	26	18	13	2
Total for Area	36	20	22	21	8	1

NOTE—100 per cent equals total number who mentioned kind of system used.

them to appreciate and utilize the features of the farm in the plumbing scheme, such as slopes, wind, hydropressure, etc. Furthermore, this would give the farmer confidence in his own ability to operate and enlarge his system. Extension schools could be conducted in the larger cities tending toward the same objective. In other words, create and educate farm or rural plumbers as part of a modern plumbing establishment.

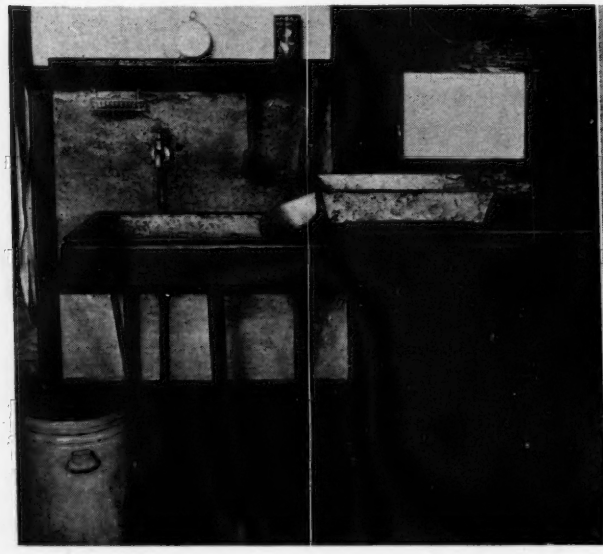
The farmer needs education in the economics of plumbing, such as cheapness of plumbing, method of adding to his system and above all to apply his native ability as a worker with tools. How can this be done? The present extension service program can be modified as in the state of Illinois where plumbing and water supply projects are pushed to the front. Home utilities, due to their influence on life and disposition of farmers and the nation as a whole deserve equality with any other projects, if not preference.

Smith-Hughes projects for high school boys can be reorganized to include instruction on home plumbing installation. One appreciates this field when realizing that government funds are available for schools offering Smith-Hughes work (Smith-Hughes Act). This work is offered in high schools where a sufficient number of students signify their intention of returning to the farm. Each student has a home project he carries on for eleven months, the teacher being the supervisor. Here is a fertile field for a Smith-Hughes instructor to instruct boys in installing plumbing. The seed from a modern home here and there will go far in spreading this type of home service.

At this juncture attention is called to the existing state laws on plumbing which restrict the farmer in the exercise of his native ability and protect urban plumbers in labor charges. Existing laws invite investigation, resulting in, it is hoped, their modification to permit the greater appreciation of benefits. Further discussion of this point is prevented due to state code differences and other points which can be put into effect without legal barriers.

For a moment try to place yourself in a farmer's position who has just decided to build a new home. He selects a plan, makes a few minor changes and then hires a carpenter, possibly a contractor, to build the house. He looks in a catalog to see what the plumbing will cost. The sink, tubs, lavatory and closet total $115. He inquires of the plumber as to his price for fixtures and installation. In due time he replies—$645.38. Something is wrong. Possibly the fixtures are purchased from the catalog house and the farmer starts to install them. Scratch your head with him. Frankly, you, like himself, are strictly up against it.

To meet such a situation and take the question mark out of the spread between $115 and $645.38, the following is offered: That all firms and the American Society of Agricultural Engineers approve and adopt a maximum of three standard bathroom "set-ups" or arrangements. What that means is, in general, that all bathrooms would be one of three designs. Let us call them bathrooms A, B and C. Every person selecting bathroom A would have a room of the same size and the fixtures all located in the exact position as all other A's. When the local dealer or any one else sells bathroom A, he sells the "rough-in" all cut to proper dimensions with a plan for assembly. The farmer can assemble this material, i. e., pipe. After that he makes but one supply connection for each kind of water and but one waste or soil stack connection. This arrangement is also a special value to the house already built.



These pictures show good examples of homemade plumbing installations. They by no means represent the ultimate to be desired in the modern farm home, but they serve very well temporarily to meet a great need and unquestionably pave the way for installation later of more modern equipment

In this case the owner simply lays his rough-in on top of the present floor, no tearing up being necessary. When that is completed another floor is built above the piping. One point is in the simplifying of the installation so it more nearly meets the farmer's ability. But that is not the only point. The plumber or mail-order house sells the rough-in job for so much and takes out most of the question mark of the spread between $115 and $645.38. It is very possible that a certain set of fixtures could be purchased with the rough-in. However, that is not necessary. Perhaps the farmer is not in a position to purchase all the fixtures he desires. Yet he does need a source of supply and pipes to the fixtures. He also needs a source of house drainage. Thus it seems advisable to do all the concealed work at once.

The question presents itself: With the rough-in purchased from one plumber will one not have to buy his equipment at his price to fit on the lay-out outlets? That question is met by standardization again. Can not all water closets be built so that the outlets are equally distant from the wall? That seems entirely possible. The same is true of other fixtures. In other words, standardize plumbing fixture supply and waste openings.

The difficulty sometimes experienced in connecting fixtures, due to lack of skill, can be reduced by improving the present method of attachment fixtures. Could not a union replace the putty attachment for closets? Surely, it is the consensus that pipe fittings are still extremely awkward and do not keep pace with plumbing progress.

The complete water and plumbing system need not be built at one time; rather build it part by part annually, or as the A.S.A.E. Farm Home Utilities Committee is wont to label it, "progressive" water and bathroom systems. The progressive bathroom can be listed as follows: First, preferably, the rough-in and the sink; then the bathtub or the flush closet, etc., year by year until it is complete.

The water system, because it is more important, should come first, however. This can start first with a small force pump inside at a kitchen sink. This eliminates the carrying of water. It still has to be pumped, but that is desirable compared to pumping and carrying. The pumping can next be reduced by placing a small open tank in the attic. The men can fill the tank morning, noon and night, thus permitting water to be at the faucet all day. The gravity tank opens the way for the bathroom. From the open gravity tank one can progress to the hydropneumatic tank in the basement or any other kind of system. In either event the pipes originally installed become an integral part of the completed system. Upon the addition of the pressure features, the pump at the sink can be connected to the cistern and furnish soft water.

Fire-Stop Characteristics of Sheet Steel Partitions

TO DETERMINE the value of sheet steel wall construction as a fire-stop, a test was conducted recently by the U. S. Bureau of Standards. The set-up employed a garage 18 feet square of standard commercial construction, the walls and roof being covered with 24 gauge galvanized sheet steel supported by rolled steel angles 1½ by 1⅛ inches.

Inside this building were placed two motor cars with wooden bodies and a total of about fourteen gallons of gasoline in their tanks. There were also a 10-foot work bench, a waste barrel, paper, shelving, and some lumber on the floor and on the steel frame overhead. One door was left partly open to admit air for the support of combustion. The test lasted four hours, and the highest temperature reported was 1339 degrees.

On three sides of the test structure were placed wooden walls at separation of 12, 18, and 24 inches, respectively. These wooden walls did not take fire until the test had progressed for one-half hour, and then the fire in each case was controlled readily by water from a five-gallon hand pump. There was also another sheet steel garage located with its nearest wall two feet from the one being burned out. The inflammable contents of the second garage did not take fire, and it is stated that it was possible to touch one's hands on the exposed wall. The building in which the fire occurred came through the test without breaking or buckling.

These tests, having demonstrated a rather unexpected degree of fire shielding in sheet steel construction, may serve to bring up for revision the whole subject of sheet steel building construction and the restrictions placed upon it in building codes, not only as regards structures of the type represented by the test garage, but also steel partitions, doors, and trims used in interior work. At the present time many building codes require that sheet steel garages be set back five feet, and in some cases even more, from the property line. In the light of the test cited, such restrictions would seem to be unnecessarily severe and that the location of sheet steel structures up to one foot of the property line might be permissible without undue fire hazard to adjacent property.

Methods of Dimming Lights for Poultry Houses

UNDER this title, and designated as Popular Bulletin No. 134, the agricultural experiment station of Washington, located at Pullman, has published a bulletin by Harry L. Garver. It is indicated as representing cooperative work between the division of agricultural engineering of the state college and the Washington Committee on the Relation of Electricity to Agriculture. In the introduction the various systems for using lights are outlined, not with respect to their advantages from the standpoint of poultry husbandry, but merely to point out that when lights are used in the morning only, no provision for dimming is necessary, whereas the several methods which involve evening light necessitate some provision for dimming in order that the fowls may find their way to the roost following the use of lights of such brilliancy as to induce activity.

The first system described is one employing two circuits, one each for the bright and dim lights, respectively. This is followed by a discussion of the resistance unit system in which special resistance units are inserted in series with the main lamp circuit to bring down the brilliancy of the lights. The third method described is a series-parallel system in which the main lighting circuit may be divided into two equal or approximately equal parts, which are then connected in series with each other so as to reduce by one-half the effective voltage across the terminals of each lamp. In all cases the proper kind and connections of switches is shown very clearly by diagrams or photographs. Considerable attention is given to the construction of homemade metallic and electrolytic resistances and the calculation of proper resistance values. The electrical efficiency of the various systems is also indicated in popular terms.

In the later part of the bulletin are included bills of materials for installing the various lighting systems described in certain standard laying-house units, also discussions of the advantages and connection of three and four-way switches and the construction and installation of automatic time switches, together with a list of manufacturers of commercial time switches.

Research in Agricultural Engineering

A department conducted by the Research Committee of the American Society of Agricultural Engineers

Research in Agricultural Engineering, 1925*

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(Continued from the August issue)

STRUCTURES

The work on structures during the year has dealt with numerous different features of the housing of farm stock and poultry, and with the storage of crops, fruits, and vegetables. It is being realized that each type of farm structure must be designed to economically meet certain rather definite conditions. A previous knowledge of these conditions is therefore essential to proper design.

Crop Storage. The Illinois station found that tile ventilators were slightly more satisfactory than "A" frame ventilators in cribs 8 feet wide and 10 feet high containing corn with 43 per cent moisture content. The most economical method of drying corn with forced air was found to be that in which unheated air is blown into a special ventilator in the center of an open crib.

Studies at the Indiana station on the requirements for apple storage showed that with no means of mechanical refrigeration or heating available, the temperature inside an apple storage house tended to follow prolonged outside conditions. The humidity within the storage rooms was easily maintained at approximately 90 per cent saturation, with 80 per cent as a minimum, regardless of outside changes. Temperatures could be reduced by natural draft to as low a degree as by forced ventilation, but not so quickly.

The Massachusetts station found that the main problem involved in the development of common storage for eastern apples is to provide some means for producing and maintaining temperatures as low as 40° F. or less in cellar storages in the early storage season. This was accomplished by the use of ice, either with or without salt, to hasten the cooling and either with or without insulation against ground temperatures as was found necessary.

As a result of five years' experiments, the Arizona station found that sweet potatoes can be kept in excellent condition in adobe storage houses until late in the spring. The advantages of the adobe storage house were found to be cheapness of material, simplicity of construction, and high insulating properties.

Studies at the Harrow Experimental Station in Canada showed that in the curing of tobacco single furnaces were unsatisfactory due to their inability to distribute the heat evenly on all sides of the kiln. Flue tobacco was cured successfully for three season, using high pressure steam from a 30 h.p. portable boiler as a source of heat. The fuel costs were lower and curing more uniform with this system.

Poultry Houses. In preliminary investigations of the air and temperature requirements of poultry to provide a basis for poultry house design, the Iowa station established the need for studies of poultry house ventilation in which all variables involved can be isolated and all factors controlled. It was found that the ventilation of poultry shelters is primarily a winter problem in which relatively low temperatures must be considered and in which excessive humidities must be dealt with instead of the low humidities existing in human shelters. Comfort is maintained when the heat produced by normal body combustion approximately balances the radiation necessary to maintain a fairly constant body temperature. Extremely low temperatures were found to reduce egg production, while high temperatures accompanied by excessive humidities caused discomfort, inactivity, and loss of appetite, and increased the susceptibility to bacterial invasion. Indications were noted that air purity as measured by carbon dioxide content is probably secondary in importance to temperature, humidity, and rate of air movement. It has been subsequently established that uniformity of temperautre is a more important factor than either air purity or relative humidity. Birds confined in an atmosphere containing a high percentage of carbon dioxide maintained apparent health and vitality so long as the temperature remained uniform and actually produced more eggs than their near relatives on the farm.

Studies at the Nebraska station of the temperature, humidity, and ventilation conditions in poultry houses showed that egg production in a house heated with a brooder stove exceeded that in an unlined, fully ventilated house, and that the increased production exceeded the cost of heating. A house which was lined but unheated gave almost the same egg production as the heated house. Lack of ventilation during the night did not appear to affect the egg production adversely.

Experiments by the British Ministry of Agriculture on the effect of lighting poultry houses of the open front type showed that the output of eggs was increased during the winter, although the total annual production was only slightly increased. The increased return was more than sufficient to pay the extra cost of lighting and labor, however. Much of the success of the system was found to depend upon the brilliancy of the lights employed. Ordinary oil lamps were of little use, but gasoline burning lamps with incandescent mantles were excellent. Acetylene was also satisfactory, provided a sufficient number of burners were placed about the shed and efficient reflectors were fitted. The best all around results were obtained with electric light.

Ventilation of Livestock Shelters. The U. S. Department of Agriculture has found that the principal factors affecting flue velocities in barn ventilation are temperature, wind, and type of construction. There is a close relationship between temperature difference and flue velocities when the ventilation is unrestricted, but when ventilation is restricted and other variable factors are introduced, there may be a wide variation in this relationship. The conclusion was drawn that if flue temperatures do have an influence on flue velocities, it will be necessary to provide insulation to maintain them. Wind was found to affect the ventilation of a barn by both pressure and suction, but is apparently not often a dominant factor until after its velocity exceeds 10 miles per hour. Its full effect is seldom obtained in the field except during warm weather, as the ventilation is generally restricted at the colder periods in proportion to the velocity of the wind. Tests of the influence of wind direction showed that the velocity of the incoming air was the same on both sides of the barn when not influenced by the wind direction.

Comparative tests of thirty representative types of automatic ventilators by the Kansas Engineering Experiment Station showed that a slight gain in efficiency is made by those ventilators which utilize the wind to the best advantage. The rotary siphoning types were the most effective, followed in order by the plain rotary, the stationary siphoning, and the plain stationary types. The siphons were found to slightly increase the effectiveness of ventilators in some cases. Slightly better results were also obtained when the siphons on two rotary siphoning ventilators were open than when they were blocked. The decrease in velocity of the moving air due to abrupt turns seemed to be an important factor in auto-

*Paper presented at the 20th annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, California, June, 1926.

matic ventilators. Ventilators having inlet pipes which projected above the bottom of the storm band were uniformly low in effectiveness, this being especially noticeable in the plain stationary group. A slight decrease in efficiency was noted in those ventilators having an inverted cone or other peculiarly shaped top. Similarly those ventilators which were equipped with shutters decreased in effectiveness in proportion to the obstruction such shutter produced. The results as a whole were taken to indicate that the most effective action in inducing air through a ventilator is the vacuum produced in the wake of the wind.

Construction of Livestock Shelters. Investigations at the Iowa station on masonry arch barn construction, involving the design, construction, and testing to destruction of a 36-foot reinforced concrete and clay block arch with a rise of 24 feet 7 inches, showed that the arch as designed on the basis of available structural principles was much stronger than required. The stress required to cause failure was equivalent to the pressure created by a wind velocity of 160 miles per hour. The results were taken to indicate both the possibility and practicability of building a barn wholly of masonry.

Silos. A continuation of studies at the Iowa station to develop a satisfactory treatment for making silo walls impervious showed that bitumen or asphalt applied so as to insure a good bond was the most satisfactory treatment. All attempts to use plaster coats of various kinds were generally unsuccessful. Studies of silo storage capacities showed that these vary widely from year to year, due primarily to differences in the water content of the silage and to a less extent to the weight of the grain.

Dairy Structures. Investigations at the California station on milk houses for California dairies indicated that concrete is an ideal material for the foundations and floors. All floors should be laid on a well drained surface at least 4 inches above the ground level. It was found inadvisable to provide an outside entrance to the milk room but to enter it from a vestibule or the wash room in order to prevent the entrance of flies. Window glass surface equivalent to 10 per cent of the floor area should be provided to permit the entrance of sufficient sunlight.

IRRIGATION

Considerable rather high grade work has been in progress during the year on different phases of the subject of irrigation. It is to be noted that many of the rather empirical tests of the duty of water for different crops on various soils are gradually giving way to more fundamental studies of the factors governing the retention in and movement of water through soils and its availability to crops, to provide a more accurate basis for economical irrigation and duty of water practices and for the design of irrigation structures.

Soil Moisture Capacity. The Washington station found that the water holding capacity and rate of water penetration in six soils were very uniform. These soils held as much as 3.5 inches of water per foot of depth when saturated in the field and 2.5 inches per foot under conditions of equilibrium after being thoroughly irrigated. This indicated that the upper 6 feet of soil will hold 15 inches of water before any loss by deep percolation occurs. It was further found that these soils must contain 0.5 inch per foot in order to have any water available for crops. Irrigation of from 2 to 3 inches every 20 days was necessary to keep them restocked with water during the irrigation season where there were no crop demands.

The California station found that the amount of soil used in its determination materially influences the moisture equivalent, the smaller the sample the larger the percentage of water retained. Some clays were found to become impervious to water during centrifuging when the amount of soil placed in the centrifuge cup was increased, and these soils reabsorbed the supernatant water when the centrifugal force was relieved. The moisture content was found to increase from the inner to the outer surface of a 60-gram block of soil, but the rate of increase was lower than that resulting from reducing the size of sample from 60 to 5 grams. The apparent specific gravity of a 60-gram block of soil was found to be significantly greater than that of a 10-gram block, and decreased continuously as the size of sample was decreased from 60 to 10 grams. The apparent specific gravity within a 60-gram sample increased significantly from the inner surface outward to a point about 6 millimeters within the sample, beyond which it remained substantially constant to the outer surface. The placing of weights on the inner surface of 5, 10, 20, or 30-gram samples decreased the amount of water retained. Subjecting the soil to centrifugal force until the moisture was in equilibrium resulted in the establishment of an equipotential region throughout the block of soil. In general, it was found that the average pore space did not limit the amount of water retained by the soil block.

Movement of Water in Soils. Studies at the American Robert College, Constantinople, on the validity of Darcy's law, Slichter's formula, and Hazen's observations with reference to clay and sand showed that the Darcy law is valid even for the semisolid state, and holds for percolation through clay of plastic consistency. Distinct departures from Darcy's law could be noticed only for semiliquid clays. Reducing the hydraulic grade from 50 down to 10 or 15 caused a rapid decrease of the coefficient of permeability, and this coefficient was fairly constant only at low heads. This was explained by the fact that the structure of a semiliquid clay is honeycombed. Results obtained in certain evaporation tests indicated that the physical constants of the water may change when the capillary channels of a shrinking clay become reduced to a certain size.

Water Losses. Laboratory studies by the Colorado station to determine the influence of wind on evaporation losses showed that under still air conditions the rate of evaporation decreases as the difference between the temperatures of the air and water increases. The maximum rate of evaporation was found to occur at about sunrise in the laboratory and during the afternoon under fully exposed conditions.

The Washington station found that the soil mulch has an inhibitory effect on moisture absorption under conditions where individual rains are not of sufficient volume to fully penetrate the mulch. This is effected by increasing the amount of current evaporation in the newly fallen moisture. There was a greater total loss of moisture from mulched soil when conditions favored evaporation. The practical use of the soil mulch in moisture conservation was considered to depend on climatic conditions which influence the prominence of either the inhibitory effect on absorption or the positive effect on retention.

Studies by the Arizona station on the effect of the transpiration of trees upon the ground water supply indicated correlations between the transpiration losses in a cottonwood and mesquite forest and climatic factors, including temperature, humidity, and cloudiness, for different stages of leaf growth. The daily fluctuations of the water table caused by the transpiration of trees and by recharge of the water supply were large, sometimes exceeding 5 inches.

Duty of Water. Controlled studies of plant and irrigation relationships by the California station failed to correlate the use of water by prune trees with any particular percentage of available soil moisture. On the contrary, they indicated a continuous need for available moisture from the beginning of spring activity to dormancy in the fall. Field studies of soil and irrigation relationships indicated that depth of ground water below the soil surface must be considered along with other factors in fixing the economical field duty of water. Widely varying the time and amount of irrigation was found to have no appreciable effect on the root development of alfalfa receiving uniform total applications of water.

Experiments by the U. S. Department of Agriculture on soils varying from very coarse to very fine sand indicated a relation between the type of soil and the water requirement of alfalfa. The yield per unit of water applied was greatest on the finest soil and ranged in order from the finest to the coarsest soil.

Irrigation Pumping. Tests of fuel oils for pumping by the Arizona station showed that under the new process of cracking the crude oils now used by some refineries, the volatility of California cracked oil distillates is higher in relation to their specific gravities than that of straight-run distillates. The cracked oils appear to have the same qualities as straight-run oils of 3° B. higher gravity.

Tests by the Montana station of the capacities of dug irrigation wells with diameters ranging from 2.5 to 16 feet and of drilled wells with diameters ranging from 1 to 2 feet

showed that the specific capacities of the dug wells varied from 0.037 to 0.39 cubic feet per second per foot of drawdown and those for the drilled wells varied from 0.022 to 1.04. The results indicated that there is no apparent definite relation between the amount of water a practical irrigation well will yield and its diameter. There is a definite relation between the yield and the drawdown. It was found further that the greater the total thickness of the water bearing strata penetrated by a well the larger will be the yield for a given drawdown.

Irrigation Structures. A continuation of the Venturi flume studies at the Colorado station showed that with the 1-foot flume a marked degree of submergence is possible before the discharge is reduced from that of the free flow, due to the formation of a hydraulic jump within the structure. It was found that the degree of the resistance to submergence increases as the width of the throat increases. The allowable degree of submergence was from 70 to 75 per cent for the smaller flumes and from 75 to 80 per cent for the larger sizes.

Studies by the U. S. Department of Agriculture have shown that the laws of hydraulics governing the movement of loose silt and detritus in open channels are only distantly related to the laws governing the scouring of a canal bed and are not directly applicable. The material of seasoned canal beds is composed of particles of different sizes, and when the interstices of the larger are filled by the smaller the mass becomes more dense, stable, and less subject to the erosive action of water. The velocity required to ravel and scour a well bedded canal in any material is much greater than that required to maintain movement of particles of that same material before becoming bedded. Colloids in either the material of the canal bed, or the water conveyed by it, tend to cement particles of clay, silt, sand, and gravel in such a way as to resist erosive effects. The grading of material from fine to coarse, coupled with the adhesion between particles brought about by colloids, makes high mean velocities possible without any appreciable scouring effect. It was concluded that irrigation canals may be designed for the velocity that is permissable when seasoned by age.

Alkali Soil Treatment. Black alkali was found to resist leaching tenaciously, in studies by the Arizona station, and could be removed from the soil successfully only after neutralization. The percolation of water through very fine sand or fine sandy loam soil was accelerated by gypsum treatment. The acceleration increased with the amount of gypsum applied, at least up to double that necessary to neutralize the black alkali present.

A continuation of tank and field experiments with impervious black alkali soils at the Oregon station showed that leaching alone was effective in removing the neutral salts, but was not effective in removing sodium carbonate or in improving the physical condition of the soil. Leaching and drainage in connection with chemical treatment were necessary in order to remove the neutral salts resulting from the decomposition of sodium carbonate. The value of heavy gypsum, sulphur, and alum treatments was indicated in this connection.

DRAINAGE

It is being realized that the design of drains without more than an empirical knowledge of the factors governing the movement and retention of water in soils is not always wholly satisfactory. The extreme complexity of the problem of soil hydraulics as it applies to underdrainage seems to have caused many drainage engineers to consider it only as a last resort. However, some more or less empirical work has been undertaken which is providing a background for fundamental work on the subject.

Ground Water Level. The Minnesota station has found, for instance, that the downward penetration of corn roots in peat soil is bounded by a zone sharply defined by the flattening out of the roots within it. This zone is not more than 3 inches thick and is not at or near the water table. Its under side, beyond which the roots do not penetrate, is approximately 18 inches above and parallel to the water table. These results were considered to profoundly influence the design of a drainage system to control the water level in marshy soil.

Studies of ground water level by the North Carolina station showed that the character of the soil rather than topographic features is the determining factor in the rise and fall of ground water levels under similar drainage conditions. The ground water level between tile lines in a level soil of uniform texture was found to rise in a smooth curve from the tile lines to a point midway between them. This curve may be very irregular in a soil of irregular texture. The rate of drop of the ground water level midway between tile lines at a 3-foot depth in Norfolk sand averaged from 1 to 1.7 feet per day in the surface foot and from 0.5 to 0.75 feet in the second foot. The ground water surface between the widely spaced drains commonly used in muck soils was found to be comparatively flat, and the rate of drop below the surface 18 inches was very slow.

Run-off. Gaugings made by the North Carolina station on a typical dredged Piedmont creek indicated that the drainage factor used in computing channel sizes for drainage improvements of this type should be increased to 1 inch per 24 hours as compared to 0.5 to 0.75 inches per 24 hours formerly used. The ratio of run-off to rainfall was found to vary from 33 to 54 per cent, with an average of 45 per cent.

Records of discharge from farm tile drainage systems indicated that a run-off coefficient of from one-third to three-eighths inch per 24 hours will give satisfactory results under average conditions of soil and spacing of laterals. Where surface water inlets are used, this should be increased to 0.5 inch. It was further found that a 1-inch rainfall will be absorbed by an open soil drained by tile to a depth of 3 feet without any run-off, where the ground water surface is at the level of the drains prior to the rain.

Drainage Structures. The North Carolina station found, in experiments on the maintenance of drainage canals in the Coastal Plain, that where the depth of water in the canals is considerable throughout the year there is little growth in the channel. Where the canal is large for the amount of water carried, resulting in a shallow normal depth of flow, conditions are favorable for a heavy growth of vegetation. The most favorable season for clearing the channel of plant growth was found to be between June 15 and August 1.

Studies on the effect of spacing and depth of tile drainage laterals showed that a spacing of 120 feet with a depth of 3.5 feet may be adopted for the more open Coastal Plain soils, with the same beneficial results and a saving in cost over the spacing of 100 feet with a depth of 3 feet. It was further found that silt will not be deposited in 4-inch laterals when laid in a sandy clay subsoil on a 0.3 per cent grade. Experiments in substituting tile of large diameter for open ditches showed that tile sizes up to 18 inches in diameter are practical when supplemented by a sufficient lateral system and surface water inlets.

Drainage by Pumping. Investigations by the California station showed that the cost of the drainage of irrigated lands by the pumping method compares favorably with that of any other method yet tried. More effective drainage was possible by the pumping method than by the use of tile or open drains, because of the flexibility of the pumping system and the greater depth to which it is economically feasible to lower the water table. The pumped water was found to be readily available for irrigation and to compensate in part for the cost of drainage by this method.

It seems advisable to again draw attention to the fact that much work has been done by soil physicists on the retention and movement of water in soils. The greater part of this work has perhaps been done from the agronomic viewpoint, and the results are therefore in more or less abstract form from the engineering viewpoint. There is undoubtedly a need for the establishment of broad general hydraulic principles governing the movement of water in soils, which, with proper modification to meet local conditions of climate, soil, and crop can be used as a basis for the design of local drainage systems for either arid or humid conditions. Cooperative efforts with soil physicists to interpret or further develop some of the known principles governing soil moisture to make them available for engineering use may therefore be desirable.

SEWAGE DISPOSAL AND WATER SUPPLY

Domestic Sewage Disposal. It seems that the knowledge of the general biochemistry of farm sewage is as yet not fully adequate to permit the design of disposal systems to meet different farm conditions satisfactorily and economically. There is a tendency for work along this line to be undertaken, however.

Studies by the Illinois station, for instance, on the factors affecting the design of farm septic tanks have shown that the two-chamber tank yields the purest effluent. Better digestion of solids, as indicated by sludge accumulation and solids passing out, is also obtained in this tank than in single or three-chamber tanks. A 48-hour retention period was found to be superior to the 24 and 72-hour periods.

The Kansas station found it advisable to begin a broad study of farm sewage disposal with an analysis and classification of conditions on the basis that purification of sewage is primarily a biological phenomenon, regardless of the type of system employed.

In a continuation of studies on the biology of sewage disposal, the New Jersey stations observed a rise and then a fall in sludge digestive activities in Imhoff tanks. High amounts of ammonia were found to correspond with low percentages of carbon dioxide production. The carbonates reached the highest peaks shortly after those for carbon dioxide and ammonia. There was in general an inverse relation between carbon dioxide production and H-ion concentration. Apparently the H-ion concentration gives a true index of the total activities taking place in a tank. Bacteriological investigations gave evidence that different types of digestion dominate at different times in Imhoff tanks. Studies of the fauna in Imhoff tanks and sprinkling beds indicated the probability that the protozoa of Imhoff tanks afford a fair criterion as to the proper working conditions therein.

Studies on the digestion of fresh solids in Imhoff tanks showed an apparent relation between the total bacterial numbers, total animal life, percentage of carbon dioxide in the gas, and the ph values of the effluent. When the tank liquid registered a pH below 7, the solids rose and foaming ocurred, while when the pH rose slightly above the neutral point the foaming subsided and the scum receded. Fresh solids, contaminated with partially digested material, were found to pass through a course of digestion similar to that passed through by uncontaminated fresh solids, there being, however, a marked difference in the rapidity of digestion.

Studies of fungi and algae of sprinkling filters indicated a seasonal fluctuation of fungi, which reached a maximum during the winter months. Film removal studies showed that, when this process started, several species of protozoa increased rapidly in numbers, there being apparently a succession of groups. When fungi became more abundant the large numbers of free swimming protozoa disappeared.

Studies in Siam on the possibility of utilizing solar light and heat for the purification of night soil showed that insulated boxes provided with tight fitting double-layered glass covers are an effective means of concentrating heat derived from the sun. The temperatures attained within such boxes under favorable conditions greatly exceeded the thermal death points of the ova and larvae of hookworms and the maximum temperature obtained exceeded the thermal death points of all vegetable forms of ordinary bacteria. These results suggest the possibility of utilizing solar light and heat for the treatment of night soil in sparsely settled rural regions of the South.

Diary Sewage Disposal. Studies at the Iowa Engineering Experiment Station showed that creamery waste differs markedly from ordinary sewage in many respects, but particularly in that it contains the carbohydrate lactose which rapidly undergoes acid fermentation, thereby rendering the waste extremely refractory to septic tank treatment. It was found that the acid producing constituents can be eliminated by direct oxidation. Four hours' aeration of 2 or even 3 per cent skim milk with activated sludge was sufficient to yield effluents which would not become appreciably acid on storage under anaerobic conditions, and which would, therefore, probably not be objectionable for admixture with sewage in septic tanks. An activated sludge was developed in about 2 weeks from 2 per cent skim milk. Aeration of 2 per cent skim milk for from 16 to 23 hours in bottles or in barrels with 20 per cent activated sludge and from 50 to 60 cubic feet of air per gallon, effected marked reductions in turbidity, acidity, total solids, organic nitrogen, and particularly in oxygen consumed and oxygen demand. Activated sludge treatment was more effective with 2 per cent buttermilk than with skim milk. Elimination of 95 per cent of the oxygen requiring constituents from 2 per cent skim milk or buttermilk was not sufficient to yield stable effluents. These results were taken to indicate that the employment of activated sludge with a view to yielding stable effluents may not be economically practical for a small plant, but that the use of activated sludge and trickling filters as preliminary processes warrant investigation.

Studies by the Maryland State Department of Health showed that flocculation and sedimentation of the casein in milk wastes is satisfactory within pH limits of 4.5 and 4.9. The supernatant liquid resulting from waste so treated has a high relative stability number. After detaining the treated waste in tanks until good sedimentation has occurred, the supernatant liquid can be discharged into a small stream or ditch without causing a nuisance.

Water Supply. The Colorado station found that distillation is the only method by which alkali water may be satisfactorily purified for drinking purposes. It was possible to distill such water from 10 to 15 per cent cheaper with coal than with artificial gas.

The Illinois station found that a well may be safely located from 50 to 100 feet from a privy vault, cess pool, septic tank, or sewer line in ordinary soil, but that a greater distance may be required in gravel, sand, or open soil. Gravity water supply systems were found to be satisfactory for many farms, although apparently the hydropneumatic system is more generally satisfactory. Studies of different types of electric water systems indicated that the actual efficiency of such equipment is low, and that many could be operated with greater economy. It required from 15 to 25 per cent more power when the range of working pressures was from 20 to 50 pounds than when it was from 10 to 20 pounds. The latter range was found satisfactory under practically all conditions.

POWER

Use of Electricity from Central Stations. Investigations of the electrical hatching of chicks by the Oregon station showed that the power in each individual incubator was on for only very short intervals of time. The power utilization during the first day was relatively high on account of the initial heating of both the incubator chamber and the eggs. The daily consumption then remained constant at 4 kilowatt-hours per day until the fourteenth day, at which point it decreased, due to the utilization of the latent heat in the egg by the growing germ. From that time on until the chick was hatched the power consumption gradually decreased, reaching a low point of 1 kilowatt-hour per day at a room temperature of 65° F. The room temperature was found to materially affect the power consumption and should not exceed 95° in order to secure economy of time in the egg cooling process. An average temperature of from 85 to 90° was found to be the best. Ventilation was found to become inefficient in available incubators when the room temperature was raised to 85 or 90°.

Investigations of the use of electric milking machines in seven dairies by the California station showed that the electrical energy required per day per cow varied from 0.033 kilowatt-hour to 0.145 kilowatt-hour, and that required per 100 pounds of milk varied from 0.16 to 0.5 kilowatt-hour.

The Oregon station, in preliminary investigations, found an average of 4.17 farm users of electricity per mile of distribution line in ten representative areas of the state, the most extensive use being for lighting and household conveniences. It was concluded that the cost of electricity per kilowatt-hour will depend largely upon the volume of use, and that aside from household appliances, pumps, and some dairy machines, the agricultural equipment at present available is not adapted to the electric drive.

Preliminary investigations by the Kansas station showed that the greatest appreciation of electric service by Kansas farmers is for illumination. The demand for the electric brooder on farms was found to be wider than that for the electric incubator. The use of electricity for pumping was

found to offer greater promise of building up a rural electrical load than any other single service. Grain binding, elevating, shelling, and cleaning were found to offer the best field of general farm development in motor belt work, while ensilage cutting and threshing if generally motorized must compete with the tractor. Possibilities for a general utility motor were indicated, but the use of electric motors for drawbar work was considered to be as yet wholly in the experimental stage. Electrical milking machines were also found to be in the developmental stage, particularly for the smaller dairy farms. The average farm user of electricity was found to use but little, if any, more current than the urban user, and line and transformer losses on many rural lines exceeded the amount of current used.

The Minnesota station concluded that the best method of bringing electric service to the farm is that in which the lines are built by the public utility and the cost thereof paid by the consumer on an actual cost basis, with due consideration for degree of benefit obtained. It was further concluded that service charges should be based on a low rate with a fixed minimum charge.

Household Electrical Equipment. Studies conducted by the University of Manitoba showed that gases of an explosive nature are generated in domestic water heaters operating on bare submerged electrodes using 220 or 110-volt, 60-cycle alternating current. The nature of these gases depends upon the material of the electrodes. Carbon electrodes give hydrogen, oxygen, carbon monoxide, carbon dioxide, and hydrocarbon gases. Aluminum electrodes generate hydrogen and oxygen most vigorously. Iron electrodes produce hydrogen and oxygen, with possibly a little carbon dioxide. The gases accumulating in the system are due to degassing of the water, the action of the water on iron producing hydrogen, and the electrolysis of the water by alternating current. The rate of generation of explosive gases with fixed electrodes is largely a function of the electric current flowing and the temperature. Apparently a larger volume of hydrogen is generated near the boiling point than can otherwise be accounted for. The danger of ignition of the gases generated is greater with heaters provided with electrodes entering from the top. It was concluded that the explosive nature of the gases generated in this type of domestic water heater makes reliance upon automatic venting extremely hazardous. Similar conditions were found to exist in electric boilers operating on alternating current with bare submerged electrodes.

Isolated Electric Plants. Experiments by the Indiana station with a home lighting plant propelled by wind showed that this plant had a capacity to produce an average daily output sufficient to light the average farm home and also to operate such appliances as a sewing machine or vacuum cleaner.

Experiments conducted by the Institute of Agricultural Engineering of the University of Oxford in England indicated that the cost of windmill generated electricity, either for small lighting or for small power purposes, is quite reasonable and such as to justify a wider use in districts remote from central station facilities. Data for different types of wind wheel showed that the disk area basis of calculation of efficiency placed multibladed wheels in the highest position, whereas the blade area basis gave the advantage to four and five-bladed types. One four-bladed type stood out clearly above the others even at low wind speeds. The next most efficient type on this basis was a wheel with semistream lined metal blades, but it was closely followed and surpassed at low wind velocities by an improved wheel with the outer trailing edge of each blade rounded off. The larger sets had an advantage at higher wind velocities, inasmuch as they had a higher generator efficiency than is practicable with the smaller sets. Emphasis was placed upon the importance, when selecting a windmill plant, of planning the load to suit the set at all seasons of the year. No greater mistake can be made than a haphazard choice of plant, without any consideration of the performance required or of the capabilities of the set chosen.

The Virginia station found that the cost of electric current from isolated farm electric plants is exceedingly high. It appeared that, over a period of time, the cost of current from the nonbattery type of plant is lower than that from the battery type of plant. A large field for improvement and development of both battery and nonbattery types is indicated.

A fuel economy test by the Missouri station on a typical nonbattery automatic light plant showed that there was very little difference between the cost of operation for a small load and that for a large load, and that if the plant is operated at all, lights as large as from 150 to 200 watts may just as well be used.

MATERIALS

The importance of establishing broad general specifications for materials used in farm equipment based upon the requirements for their use is being recognized, and some work along this line has been in progress.

Binder Twine. Tests of binder twine by the Indiana station showed, for instance, that the average tensile strength for most of the brands tested was above the guaranty, but that the lack of uniformity in both tensile strength and thickness of the twine was the cause of breaks. The tensile strength was found to be directly proportional to the number of fibers in the twine and the number of fibers was of greater importance than their length. It was further found that the thickness of binder twine is not always an indication of its strength, since loosely twisted twine allows fibers to slip, causing the stress to be carried by individual fibers.

Concrete. In cooperative studies with the U. S. Department of Agriculture on the effect of immersing concrete and sand mortar cylinder specimens for one year in lake water containing from 2.34 to 4.72 per cent of a combination of magnesium and sodium sulphates, the Minnesota station found that none of the high alumina cements used showed evidence of any deleterious action. None of the standard Portland cement cylinders cured in steam at a temperature of 212° F. showed any surface action of the lake water, regardless of the length of time they were so cured. Curing in water vapor at temperatures of 155 and 100° was found to be of no value. Considerable deterioration was evident in all cylinders cured in the laboratory in the moist closet, followed either by further curing in water or by storing in air, or both. Under some conditions additions of blast furnace slag, calcium chloride, Cal, and ironite increased the resistance of the concrete, while additions of volcanic ash and Alkagel "A" were of little or no benefit.

Studies by the University of Saskatchewan revealed the reasons for some of these phenomena by showing that although the main action of sodium sulphate on Portland cement is the extraction of lime, during the latter stages both silica and alumina are removed. The extraction is speeded up in the presence of sodium sulphate and the effect increases with the concentration. However, the results indicated the importance of making impervious concrete even when in contact with fresh water only. Further experiments showed that the presence of chlorides is not a contributing factor in the disintegration of cement by sulphates. Magnesium sulphate was found to react with the lime liberated through the natural hydration of the cement. In mixtures of sodium and magnesium sulphates, the magnesium sulphate disintegration controls as long as there is any of that salt present. The sodium sulphate disintegration begins only after the magnesium sulphate is removed. The results also indicated that the complete disintegration of Portland cement may take place in sulphate solutions without crystallization of substances, with a resultant increase involume, having any important influence, although this may have an influence under certain conditions.

The U. S. Bureau of Standards showed that although the treatment of cement products such as drain tile by impregnation with molten sulphur increases their strength very markedly and decreases their absorption, it does not in any manner increase their life in alkali soils.

Studies by the Colorado station showed that beet pulp has a destructive effect upon both mortar and concrete specimens. This action was not great up to 150 days of storage in beet pulp but increased progressively for longer periods.

Roofing Materials. A continuation of studies of the durability of prepared roofing by the Iowa station indicated that exposure to the sun is one of the most important deteriorating factors.

Experiments by the Alabama station to determine if there is a correlation between certain physical tests, simulating

service conditions, and the wearing qualities of bituminous materials showed that in the majority of cases the tensile strength of the materials decreased markedly after exposure to the weather for one year. The time required to break down under a flame test also decreased in the majority of cases after exposure, although the sheathing surface appeared to retain its resistance to heat better than the weathering surface. However, exposure to the weather seemed to increase the temperature at which flowing began. Exposure seemed to decrease the tendency to absorb moisture but to increase the volatility.

Fence Posts. In a continuation of studies of methods to prolong the service of wood fence posts, the Missouri station found that setting in gravel and charring did not pay, while painting with hot carbolineum was perhaps better than painting with creosote. Double tank treatment with creosote was the most effective, the 5-hour treatment being better than the 2-hour. It did not pay to treat some varieties, particularly honey locust, willow, cottonwood, and white oak, unless the whole post was treated. Black ash, sassafras, red oak, and ironwood made good posts if given the double tank creosote treatment.

The Iowa station found that cottonwood, willow, and elm fence posts which were given a good creosote treatment 17 to 18 years ago are still in service and in good condition.

LAND CLEARING

The progress results of land clearing work indicate that for the most part it has been confined to the manipulation of available scientific and engineering principles.

Stone Removal. The Wisconsin station showed that the mudcapping method of rock blasting is entirely satisfactory for breaking ordinary rocks and boulders. The total cost of rock blasting was considerably higher when holes were drilled into the rock than when the mud capping method was used.

Brush Removal. The Minnesota station found that the average number of man hours required to brush an acre was 32.4. Cutting brush in the late summer to prevent sprouting back was considered to be a practice of questionable value under ordinary farm conditions. It was found that sheep must be starved down to the pasture to do any real good from the standpoint of brush removal.

The Missouri station found that in order to effectively use a sprout mower the stumps must be cut low so that they will not interfere with the machine frame or slow up the beater chains. The machine should be used the first year after the timber is removed, as second year growth is too large for effective operation. At least two strippings per year are necessary.

The Alabama station found that the cost of brushing varies from one-half of the final cost in light timber to one-eighth of the final cost in heavy timber, and that in complete clearing the cost of brushing is about twice as great for pulling as for blasting.

Stump Removal. The Minnesota station found that stumps may be removed by blasting at least one-third cheaper when the soil is full of moisture than when it is dry. Forest fires were found to be more effective than 4 years of decay in reducing stumping costs. Stumps that were dead, partially decayed, and burned were cleared with a smaller expenditure of man and horse labor than stumps that were green when burned. On the basis of 1914 price levels, the cost of post-fire clearing of all conditions of stumps was only about half of that of pre-fire clearing.

The Alabama station found that the final cost per stump is about the same for pulling as for blasting. The best results in blasting were obtained when the charge was placed at a depth of twice the diameter of the stump and 14 in. from the base. This was especially important in the case of stumps 15 in. and over in diameter. Other conditions being equal, the efficiency of blasting was found to be in direct proportion to the amount of free water in the soil up to the point of saturation. Best results were obtained in loosening stumps by blasting while under tension from the puller. Heavy blasting before pulling generally did not reduce the amount of soil on the roots on removal.

The British Ministry of Agriculture found that hedge and stump clearing done by hand is efficient but is too slow and expensive. Tests of 5 and 10-ton timber jacks showed that the actual movement of the jack was relatively small and was liable to be partly absorbed in overcoming the resilience of the tree and the ground. Tests of a vertical stump puller showed that, while this machine compared favorably with other machines as regards cost, a large amount of earth adhered to the stump roots as compared with methods requiring a sudden extraction. Tests of a triple horse stump puller of 300,000 pounds estimated maximum extracting power showed it to be one of the most rapid for the extraction of small stumps. Steam tractors gave results in stump pulling comparing favorably with those from other mechanical devices, although the stumps extracted were relatively small. A great deal of hand grubbing was necessary for larger stumps. Ordinary farmer's dynamite, while giving a high average cost per stump, gave a low average cost in terms of cubic feet of stump removed. It was also possible to remove large stumps which were beyond the capacity of ordinary mechanical devices. Explosives were the most advantageous from the standpoint of handling and treatment of timber after removal.

SOIL EROSION

Work on soil erosion is beginning to consider the factors governing the reasons why soils erode.

Soil Loss. The Missouri station found, for example, that the amount of soil lost by erosion from land planted to soy beans in rows may be very great. It was considered doubtful that soy beans as commonly grown are a valuable soil building crop on the rolling lands of Missouri.

The U. S. Department of Agriculture, in cooperation with the North Carolina Department of Agriculture, showed that run-off is apparently proportional to the amount and intensity of rainfall rather than to the amount alone. Erosion seemed to follow the same principle to some extent, although the controlling factor appeared to be cultivation. The character of the vegetative covering on the soil was found to be the principal factor in controlling erosion. Grass sod was strikingly efficient in decreasing both run-off and erosion. Corn also showed a beneficial effect in both cases, but erosion was increased under cotton. The amount of run-off decreased with increase in the length of the plat.

CONCLUSION

Everything indicates that the character of the research and investigation in agricultural engineering is improving. A great deal of comparative experimenting and testing of a local nature is still going on, but the tendency is to recognize the importance of establishing the broadly applicable fundamental principles governing the performance of agricultural operations if the cost of labor and power required is to be reduced to a minimum.

Farm Fire Prevention and Protection

FARM fire losses in 1925 showed an increase of 65 per cent over the losses in 1920; the annual total now approximates $150,000,000. Over a period of years up to 1923 lightning was the chief cause of farm fires, being responsible for 13.5 per cent of the total. Then followed in order defective chimneys and flues, 13 per cent, and sparks on roofs, nearly 7 per cent.

In 1924 defective flues headed the list of fire causes being responsible for 14 per cent of the losses that year. Sparks on roofs increased to 10 per cent. The conclusion is drawn from these percentages that maintenance has been neglected, that old roofs have become a source of danger, and that chimneys and flues have not been inspected and repaired.

The agricultural committee of the National Fire Waste Council, sponsored by the insurance department of the Chamber of Commerce of the United States of America, is planning to give the farmers the benefit of the experience of the leading fire protection and fire prevention engineers of the country in eliminating fire hazards and assisting them in protecting adequately their property. Subcommitttees are now being appointed to study various phases of the problem.

The Farm Structures Division of the American Society of Agricultural Engineers is one of the principal organizations affiliated with the N.F.W.C. agricultural committee and is represented on that committee by T. F. Laist, chairman of the Committee on Farm Fire Prevention and Protection, and Deane G. Carter, chairman of the Farm Structures Division of the Society.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Test of New Wall Indicates Stiffness (Concrete Chicago, Cement Mill Ed., 27 (1925), No. 6, pp. 37-39, figs. 5).—The results of a test by Columbia University of a structure consisting of two walls each 7 feet long and 8 feet 6 inches high spaced 15 feet in the clear are reported, the purpose being to determine the strength of a reinforced mortar wall 4.5 inches in thickness. Under a load of 1,153 pounds per foot, the reinforced mortar wall showed a lateral displacement at mid-height of the wall section of 0.05 inch.

Annual Report of the Commissioner of Reclamation (U. S. Bur. Reclam. Ann. Rpt., 24 (1925), pp. 178, figs. 8).—This report summarizes the work of the U. S. Department of the Interior Bureau of Reclamation for the fiscal year ended June 30, 1925.

Rural Electrification in England (Elect. World, 86 (1925), No. 25, p. 1252).—Data on the use of electricity on farms in England are briefly presented, which are based on an average farm of 150 acres. The cost of electrification is estimated at about $750 for farm equipment including three motors aggregating 10 hp., thirty-six electric lights, all necessary wiring, and complete household appliances. The cost of distribution lines is placed at between $2,300 and $2,900 per mile for 6,600 volt overhead three-conductor lines. The opinion is expressed that farmers will find electricity profitable if it can be secured for 16 cents per kilowatt-hour for lighting, 4 cents for heating and cooking, 8 cents for power, and from 2 to 4 cents for plowing.

[Agricultural Engineering Studies at the Illinois Station] (Illinois Sta. Rpt. 1924, pp. 174-183, figs. 5).—Experiments by F. P. Hanson on the control of soil erosion have shown that terraces gives satisfactory service when properly built and used.

Plow draft studies on different soil types by R. I. Shawl indicated that the amount of draft varies with the different soil treatments, and that the addition of organic matter to the soil reduces the power required for plowing.

Tests of methods for harvesting soybeans by E. W. Lehmann and I. P. Blauser indicate that at present there is a loss of soybeans ranging from 15 to 45 per cent, depending upon the methods used and the condition of the beans.

Studies by Lehmann and R. C. Kelleher on the factors affecting the design of farm septic tanks have shown that the two-chamber tank gives the greatest purification of effluent. Better digestion of solids is obtained in the two-chamber tank, as indicated by sludge accumulation and solids passing out. The 48-hour capacity tank shows a marked improvement over the 24-hour capacity tank. As compared with the 48-hour capacity tank, however, the 72-hour capacity tank showed lower turbidity, lower oxygen consumption, and a smaller rate of sludge accumulation. On the other hand, the 48-hour tank was found to contain less total sludge, less settleable solids, and less residue on evaporation. These results are considered to indicate the superiority of the 48-hour tank. Considerable improvement in the purification of effluent has been obtained by adding another chamber to still further treat the effluent from a given preceding chamber. Curves of turbidity, residue on exaporation, and settleable solids platted against time show erratic results in the small chambers of the 3-chamber tank. This is considered to be due probably to the fact that the first chamber fills up somewhat and then discharge considerable amounts of floc at one time, thus producing a variation in the quality of the effluent.

The results as a whole are taken to indicate that a 2-chamber tank is more efficient than a 3-chamber or a single chamber tank of equal size under the conditions encountered and with the size of tanks studied. This is thought to be due to the fact that the period during which the sewage remains in each of the two chambers is most favorable to settlement and digestion of solids by bacterial action. In addition the two-chamber tank has more baffling effect than the one-chamber tank.

Measurements of the flow of farm sewage from two farm homes at which the average water consumption were 30.2 and 40.6 gallons per person per day showed that the average sewage flow over a period of 14 days was 37.4 gallons per person per day for the latter.

Studies of different types of electric water systems by Lehmann indicate that the actual efficiency of such plants is low. However, the cost of operating them is so light, and they are so convenient, that the question of efficiency is not considered of great importance when these methods are compared with other methods of pumping. It is considered evident, however, that many plants could be operated with greater economy than at present. It requires from 15 to 25 per cent more power when the range of working pressures is set for from 20 to 50 pounds than when set for 10 to 20 pounds. Under practically all conditions the latter range of working pressures has been found to be satisfactory.

Effect of Size and Shape of Test Specimen on Compressive Strength of Concrete, H. F. Gonnerman (American Society Testing Materials Proceedings, 25 (1925), pt. 2, pp. 237-250, figs. 4; reprinted Lewis Institute, Structure Materials Research Laboratory Bul. 16 (1925), pp. 16, figs. 4).—Studies conducted at the Lewis Institute to determine the effect of size and shape of 1,755 test specimens on their compressive strengths are reported.

The 6 by 12-inch cylinder generally used for compression tests of concrete was found to be a satisfactory form of specimen. However, because of the likelihood of nonuniform placing, it is recommended that the use of this size of cylinder be limited to aggregates 2 inches or less in diameter.

The 4 by 8-inch or 5 by 10-inch cylinders were found suitable for the smaller sizes of aggregate. It is concluded that the ratio of diameter of cylinder to maximum size of aggregate should not be less than about 3, and that for aggregates larger than 2 inches, 8 by 16-inch cylinders or larger should be used.

Lower strengths were usually obtained with the larger cylinders of a length equal to 2 diameters. The decrease in strength with size of cylinder was not important for diameters of 6 inches or less. The 6 and 8-inch cubes tested at ages of from seven days to one year gave strengths averaging, respectively, 18 and 13 per cent higher than those given by 6 by 12-inch cylinders. The compressive strength increased with age for all forms of moist cured specimens.

Industrial Water Supplies of Ohio, C. W. Foulk (Ohio Geological Survey, 4. ser., Bulletin 29 (1925), pp. 406).—The purpose of this bulletin is to present by chemical analysis the nature of the waters of Ohio, and to give some account and discussion of water problems, such as the source and character of the impurities, the methods of water analysis, the behavior of water in use, and the purification of water for industrial purposes. This bulletin is in three parts. Part 1 contains general information about water and its behavior in use, and contains chapters on origin of the impurities in water; meaning of water analysis; ways of stating the results of water analysis; calculating hypothetical combinations; methods of chemical analysis; interpretation of industrial water analysis; hardness and water in the household; scale, boiler compounds, and internal treatment; corrosion; foaming and priming; and purification of water for industrial use. Parts 2 and 3 deal, respectively, with the chemical character of the surface waters and the ground waters of Ohio.

Use of Water in Irrigation, S. Fortier (New York and London: McGraw-Hill Book Co., 1926, 3. ed., pp. XIII+420, pls. 6, figs. 112).—This is the third edition of this book.

Drying Apparatus for Grass Seed, W. Fischer (Grunland, Berlin, 44 (1926), No. 2, pp. 22-26, fig. 1).—An apparatus for the drying of grass seed is described and illustrated. It has been found that grass seed containing more than 20 per cent of moisture is likely to take on a bad color and to fail to develop a normal germination power. The drying system employs air heated to around 40 degrees Centigrade (104 degrees Fahrenheit). This reaches from 50 to 60 degrees in the drying cells and is cooled to from 20 to 25 degrees through the moisture evaporation at the point of exit. The seed is subjected to the current of warm air only about 1.5 minutes and must be cooled before sacking.

O. A. C. Portable Poultry Fence, F. L. Knowlton (Oregon Station Circular 69 (1926), pp. 4, figs. 5).—Working drawings and a bill of material for this structure are presented.

Dairy Buildings for Kansas, J. B. Fitch and V. R. Hillman (Kansas Station Bulletin 236 (1925), pp. 4-25, figs. 40).—This bulletin, prepared in cooperation with the engineering experiment station of the Kansas State Agricultural College, presents information on the planning and construction of dairy barns to meet Kansas dairy conditions, together with data on necessary accessories and equipment and an appendix listing available dairy barn and dairy equipment plans.

Subsoiling Machinery and the Requirements of Deep Plowing, L. Engelbrecht (Landw. Jahrb., 62 (1925), No. 6, pp. 879-945, figs. 43).—The first part of this report traces the history of deep tillage in Germany and draws special attention to the corresponding development of deep-tillage machinery. The second part comprises an analysis of the engineering mechanics involved in the development of the necessary machinery on the basis of the requirements of deep tillage.

Tests of deep tillage tools showed the superiority of the goosefoot share over the right angled triangle and chisel shapes. The chisel shape was valuable for some purposes, but the triangular share was rejected on account of its excessive draft.

A bibliography is appended.

Progress Report on Engine-Starting Tests, J. O. Eisinger (Journal Society Automotive Engineers, 18 (1926), No. 2, pp. 147-152, figs. 12).—Continuing previous experiments at the U. S. Bureau of Standards, it was found that within certain limits richness of the fuel determines the number of revolutions the engine must make before an explosion is obtained. Richness of the mixture in the

cylinder rather than that of the mixture leaving the carburetor was found to determine whether or not an explosion will occur. This is believed to be a function of the delayed vaporization of fuel left in liquid form in the manifold and cylinder during previous cycles.

Soil Erosion of Soybean Land, F. L. Duley (Journal American Society Agronomy, 17 (1925), No. 12, pp. 800-803).—Studies conducted at the Missouri experiment station are briefly reported which showed that the amount of soil lost by erosion from soy bean land on a 3.68 per cent slope was greater than from corn land where the corn followed clover and was itself followed by wheat. The loss of soil from soybean land during the first year was only about half that from land in corn continually, but during the second year, which was one of greater rainfall, the erosion from the former was much higher.

The erosion from soybean land was eighty-six times as great as from sod land. The nitrogen lost in the eroded soil from the soybean land averaged 32.18 pounds per acre. It is concluded that soybeans cannot take the place of sod legumes, such as the clovers, on rolling land because they do not give sufficient protection to the soil.

Soil Structure, Its Determination as the Relation of Capillary to Noncapillary Porosity, and Its Importance as a Productiveness Factor, A. G. Dolarenko (Nauch. Agron. Zhur. (Jour. Landw. Wiss.), 1 (1924), No. 7-8, pp. 451-474, figs. 8; Ger. abs., pp. 472-474).—Studies conducted at the Moscow Agricultural Academy are reported which led to the conclusion that only certain determinate physical and mechanical properties of the soil complex should be considered in the investigation and evaluation of soil structure. The capillary and noncapillary porosities of soils, and especially their ratio, were found to have the greatest influence on the factors governing soil structure of any of the dynamic properties of soils.

The presence of both types of porosity in soils was found to have a definite influence on permeability to air and water, water capacity, capillary rise, evaporation, ratio of water to air, biological activity, accumulation of soluble nutrients, concentration of soil solution, degree of dissociation, H-ion concentration, and gaseous exchange.

It is concluded that the extreme variability of the soil structure is due to the two properties of capillary and noncapillary porosity and that individual structures such as single grain, crumb, or clod structures represent special values of the ratio of the two types of porosity. This ratio on the volume basis is termed the porosity factor of soil.

A fixed and uniform correlation was established between the porosity factor of a fractionated soil and its productiveness factors. The same correlation was established for soil not fractionated. The optimum porosity factor was established on the basis that, with 50 per cent void space, more than one-half should be noncapillary porosity. It is concluded that the production and maintenance of the optimum porosity factor should serve as the basis for the development of tillage operations and of machinery for performing them.

A method for determining the volume of capillary and noncapillary porosity of soils is outlined.

Evaporation Power of Soil, A. G. Dolarenko (Nauch. Agron. Zhur. (Jour. Landw. Wiss.), 1 (1924), No. 5-6, pp. 339-349, figs. 4; Ger. abs., p. 349).—In a contribution from the Moscow Agricultural Academy a method and apparatus for determining the evaporation power of soil are described, and studies on the influence of soil cultivation on evaporation are reported.

The method determines the amount of moisture removed from a unit of soil surface per unit of time by a current of dry air. Harrowing of black fallow in the spring was found to decrease evaporation about 20.7 per cent, plowing about 50 per cent, and maintenance of black fallow about 59 per cent.

Heating Appliances for Flue-Curing Tobacco, D. D. Digges (Canada Department Agriculture Pamphlet 51, n. ser. (1925), pp. 13, figs. 6).—Studies at the Harrow Experimental Station are reported, which showed that in the curing of tobacco single furnaces were unsatisfactory due to their inability to distribute the heat evenly on all sides of the kiln. Flue tobacco was cured successfully for three seasons, using high pressure steam from a 30-horsepower portable boiler as a source of heat. The fuel costs were lower and the curing more uniform with this system.

Electrical Protection and Safety Apparatus for Agricultural Use, C. H. Dencker (Technik Landw., 7 (1926), No. 1, pp. 6-11, figs. 16).—Safety appliances for use in farm electrical installations are described and illustrated, and data from tests of such things as fuses, switches, grounding devices, automatic circuit breakers, etc., are reported.

Water Power and Irrigation in the Madison River Basin, Montana, J. F. Deeds and W. N. White (U. S. Geological Survey, Water-Supply Paper 560-A (1925), pp. II+30, figs. 2).—The results of a survey of the water power and irrigation possibilities in the Madison River basin, Mont., are presented.

It is stated that the basin yields annually more than 1,400,000 acre-feet of water which can be used for the development of hydroelectric energy and for irrigation. It is estimated that the undeveloped power resources on the river amount to 136,000 horsepower. About 2.1 per cent of the drainage area is irrigated. In parts of the basin are flood plain areas that may be susceptible of successful reclamation by drainage, diking, and irrigation.

Temperature of Water Available for Industrial Use in the United States, W. D. Collins (U. S. Geological Survey, Water-Supply Paper 520-F(1925), pp. II + 97-104, pls. 4).—Data on the temperature of surface and ground waters obtainable at different points in the United States are presented and discussed.

They indicate that the temperature of ground water available for industrial supplies is generally from 2 to 3 degrees Fahrenheit above the mean annual air temperature if the water is between 30 and 60 feet below the surface of the ground. At a depth of 10 feet the temperature may range from 10 degrees above to 10 degrees below the mean annual temperature. An approximate average for the increase in temperature with depth is about 1 degree for each 64 feet.

The mean monthly temperature of surface water at any place is generally within a few degrees of the mean monthly air temperature when the air temperature is above the freezing point.

Influence of Moisture on the Spontaneous Heating of Coal, J. D. Davis and J. F. Byrne (Industrial and Engineers Chemistry, 18 (1926), No. 3, pp. 233-236, figs. 5).—Studies conducted at the Pittsburgh Experiment Station of the U. S. Bureau of Mines are reported.

The results showed that Pittsburgh and Sharon coals as received will not heat in dry oxygen, but that the temperature drops instead, owing to moisture vaporization. When treated with oxygen saturated at room temperature such coal will heat or cool, depending upon the rate of circulation of oxygen and the resultant rate of moisture vaporization. Bituminous coal dried in an inert atmosphere or in vacuum will invariably heat spontaneously from 70 degrees Centigrade, provided the temperature of drying has not exceeded 140 degrees or the time of drying has not been excessive.

The results are taken to indicate that since prolonged drying to as high a temperature as 140 degree is not likely to occur in storage, reversal of colloidal state is not an important factor in diminishing heating rates in storage. Under laboratory conditions a coal that has been moderately dried heats somewhat faster than a moist coal. It is therefore considered better to store the coal moist than dry, since the pores in the coal which are filled with moisture have no space for the adsorption of oxygen. Futhermore, if the coal is moist enough to be out of equilibrium with the atmosphere, moisture will slowly evaporate and there will be cooling due to latent heat of vaporization. A very dry coal, on the other hand, will take up moisture from the atmosphere and the heat of condensation will raise its temperature.

Index of Analyses of Natural Waters in the United States, W. D. Collins and C. S. Howard (U. S. Geological Survey, Water-Supply Paper 560-C(1925), pp. II+53-85).—A list of published collections of analyses of natural waters of the United States is presented, which is intended to include all federal and state reports of geological surveys, experiment stations, and health departments. In addition references are given to journal articles that contain collections of analyses.

Book Reviews

"Problems in Blue Print Reading," by Drew W. Castle, vocational director, Joliet Township High School and Junior College, Joliet, Illinois, is one of the Selvidge series of instruction manuals. It is a treatise on blue print reading. The method of teaching blue print reading described in this treatise is the result of an effort to find a device for effectively teaching the subject without passing through the intermediate and unnecessary stage of drawing. The book is divided into two parts, the first part including important information topics such as principle, sections, dimensions and notes, conventions and common mechanical terms, sketching, and how to work the blue print reading problems. The second part is devoted to thirty blue print reading problems. It is published by the Manual Arts Press, Peoria, Illinois, and the price is $1.44.

"Agricultural Mechanics," by Robert H. Smith, instructor in farm mechanics at the New York State School of Agriculture, is a new book in which a skilled mechanic presents a course of instruction adapted to the use of all farmers. The book does not aim to make the farmer a plumber, carpenter, blacksmith, harness maker, tinner, or painter, but rather to give him such essentials of these and other trades as will enable him to make satisfactory practical repairs on farm equipment and to construct new devices as will assist him in his work. The book contains chapters on the farm shop, tools, tool operations, geometrical construction used in farm carpentry, mechanical drawings, selection, use, and care of lumber, devices for the farm shop, barns, dairy, poultry house, surveying, painting, glazing, farm forge shop work, farm water supply, care and repair of harness, rope and its use on the farm, concrete in farm practice, and gas engines. The book contains 364 pages and 366 illustrations. It is published by J. B. Lippincott Company, Philadelphia, and the price is $3.00.

Rural Electric Experiments, C. H. Churchill, Jr. (C. R. E. A. Bul., 2 (1926), No. 3, pp. 8, pl. 1, figs. 5).—Experiments on the development of an electric milk cooler outfit for the small and medium sized dairy are briefly reported and notes on its construction are presented. Data are also presented on an electric wood sawing outfit and on threshing and feed grinding experiments.

AGRICULTURAL ENGINEERING

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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RAYMOND OLNEY, Editor

Farm Equipment and Cotton Production

THE effective use of machinery in cotton production is one of the outstanding problems in the South, from the viewpoint of the agricultural engineer.

"No other crop compares with cotton in supplying one of the prime necessities of life; provides so much employment; or enters so largely into the commerce of the world," according to J. A. Dickey, economist of the University of Arkansas.

However, there is a great contrast between the commercial value of cotton and the condition of the cotton farmer. It requires more hand labor than other crops so extensively grown. Much of the crop is produced by men who handle not much over 15 acres per family. The usual equipment consists of hand tools and one-horse implements. As a result the hours of man labor for cotton range from 40 to 150 hours per acre and from 15 to 90 hours for the preharvest operations.

Mule labor is from 33 to 60 hours per acre. From 50 to 70 per cent of the cost of producing cotton is included in the power and labor factors. If the cost of producing cotton is in the neighborhood of 25 cents per pound, more than 16 cent is included in the man and mule costs.

These figures indicate two things. First, the very great range between 40 and 150 hours per acre shows that the normally high amount of man labor may be materially reduced if the methods of the extensive cotton farmer are adopted. Second, the fact that approximately two-thirds of the cost of production is for power and labor indicates that if costs are to be lowered these items must be reduced.

J. B. Davidson of Iowa State College has reported that corn has been produced with only 4 to 5 hours of man labor, whereas we normally expend several times as much man labor per acre.

If this reduction can be made in corn production, then certainly there is an opportunity for the machinery man and the agricultural engineer in experimental or demonstration work to effect a reduction in the production of cotton. Cotton under reasonably favorable conditions can be produced for far less than the normal 60 to 100 hours per acre.

This fact is strikingly indicated by the experience of the Texas planters who produced cotton in 1923 with only 15 hours of preharvest man labor per acre.

W. B. Mann, of Lee County, Arkansas, told an audience of farmers recently that last year on one of his farms cotton produced under the commonly used methods cost him more than 25 cents a pound. Another of his farms was worked with machinery and managed according to more modern methods. Mr. Mann said, "I secured the best accountant I could find to keep my books, and I know that I could sell the cotton produced under modern methods at 10 cents a pound and make a profit."

DEANE G. CARTER

"Fireproof" vs. "Fire-Resistant"

AMONG engineers and others particularly concerned with fire prevention and fire fighting the term "fireproof" has come up for rather severe criticism.

The question seems to have been raised by the fact that there have been a number of disastrous fires in buildings which were themselves composed of incombustible materials and, therefore, completely fireproof in the sense that the word commonly is employed. These fires have occurred in the combustible contents of the structures, and the point is made that a building is only as fireproof as its contents. A represenative of the New York underwriters is quoted as saying that the term "fireproof" gives a false sense of security. It is pointed out that when a fire occurs in a large building of so-called fireproof construction it may be more than ordinarily difficult to bring under control, due to the height of the structure and the presence of elevator shafts, etc., which act as flues and serve to spread the fire from floor to floor. In consequence this underwriters' group advocates the installation of automatic sprinklers in "fireproof" office buildings. In this connection it is stated by certain construction engineers that buildings of heavy timber, or "'mill" construction, when provided with automatic sprinklers, have practical fire resistance in equal measure with those of masonry construction.

In view of the fact that, while buildings of incombustible materials cannot burn down, they can and do burn out, sometimes with damage to the structure itself, the proposal is advanced that the term "fireproof" should be supplanted by the expression "fire-resistant," as being more accurately descriptive.

Agricultural engineers, because of the predominating extent to which frame construction is employed in farm buildings, will be interested in a specific instance of the degree of security, at least from an insurance standpoint, which may be secured through automatic sprinkler protection. At Mackinac Island, Michigan, the Grand Hotel, a large, rambling, summer resort building, of wooden construction put up many years ago and surrounded by similarly inflammable structures of smaller size, seemed to hold promise of a very serious conflagration should fire get a good start in any part of the property. Within the past year an automatic sprinkler system was installed at a cost in excess of $100,000.00. In consequence there was effected in fire insurance premiums an annual reduction equal to 20 per cent of the investment in sprinkler equipment, the rate being in fact lower than if the entire property were of so-called fireproof construction.

Attending Meeting

WE HEAR more or less criticism of the increasing tendency of professional and business men to get together in conventions and meetings. The criticism implies that, to a large extent, it is a waste of time and productive effort. The number of conventions has increased rapidly during the past few years, and undoubtedly these meetings do involve some loss of productive effort. On the whole, however, this loss is many times effected by the benefits which individuals, the professions, the industries and business in general derive from them.

The inspiration alone one receives from a worthwhile meeting usually justifies his attendance. He renews his old acquaintances and makes new ones. He gets new ideas, new viewpoints. It unfolds to him a new vision of his work. He should return home much enriched by his experience and feeling well repaid for the time and expense involved.

We are living in a rapidly developing age. The professional man especially finds it necessary to keep pace with development if he is not to be left by the wayside. For that reason attendance at meetings of members of his profession is most important to him.

A. S. A. E. and Allied Activities

North Atlantic Section Offers Meeting Program

THE application of engineering to agriculture—creating an engineered agriculture comparable with our engineered manufacturing industries—is a tremendously big thing, but one which the agricultural engineers have tackled with the energy and enthusiasm so characteristic of the group comprising this branch of the engineering profession. A number of the more outstanding problems to which agricultural engineers are directing their attention will be presented and discussed at the meeting of the North Atlantic Section of the American Society of Agricultural Engineers to be held at Pennsylvania State College, State College, Pennsylvania, October 11, 12, and 13. All who are interested in the engineering phases of agricultural development, including the development of mechanical equipment for farming, are cordially invited to attend the meeting. Tentative program for the meeting follows:

TENTATIVE PROGRAM

Meeting of the North Atlantic Section of American Society of Agricultural Engineers, State College, Pennsylvania, October 11, 12, 13, 1926

Morning Session—October 11

PAPER: "Results of the Farm Equipment Research Survey"—S. H. McCrory, chief division of agricultural engineering, U. S. Department of Agriculture

PAPER: "Dilution of Crankcase Oil in Kerosene Burning Engines"—L. G. Heimpel, professor of agricultural engineering, Macdonald College, Quebec

Afternoon Session—October 11

PAPER: "Farm Building Ventilation"—F. L. Fairbanks, assistant professor of rural engineering, New York State College of Agriculture

PAPER: "Requirements for Farm Building Paints"—L. H. Trott, sales engineer, New Jersey Zinc Sales Company

Evening Session—October 11

ROUND TABLE DISCUSSIONS—1. Farm Buildings
2. Agricultural Engineering Education
3. Farm Power
4. Farm Home Utilities
5. Farm Equipment
6. Rural Electrification

Morning Session—October 12

PAPER: "Fruit Storage Problems"—L. M. Marble

PAPER: "Farm Equipment Research"—H. B. Josephson, research engineer, department of farm machinery, Pennsylvania State College

Visit to the Pennsylvania Agricultural Experiment Station

Afternoon Session—October 12

PAPER: "Economic Aspects of Rural Electrification"—Dr. G. S. Warren, professor of agricultural economics, New York State College of Agriculture

PAPER: "The Farmers Views on Rural Electrification"—Miles Horst

PAPER: "Rural Electrification in Virginia"—C. E. Seitz, professor of agricultural engineering, Virginia Polytechnic Institute

PAPER: "Rural Electrification in New Hampshire"—W. T. Ackerman, electrical project engineer, New England Rural Electrification Project, Durham, New Hampshire

Evening Session—October 12

Banquet and get-together of members and guests

Morning Session—October 13

Business meeting of North Atlantic Section

Southwest Section Meeting to Feature Power and Machinery in Cotton Production

THE effective use of power and machinery in cotton production is attracting more attention than perhaps any other agricultural engineering problem in the South.

Farmers in the western portion of the cotton belt are producing cotton with 15 hours of man labor per acre, as compared to the normal 60 to 75 hours. The cost of production can and is being reduced to as low as ten cents per pound.

Larger tools, more power, advanced methods and greater production per man is one of the solutions of the problem. The Southwest Section of the American Society of Agricultural Engineers has called a meeting in Dallas, Texas, Friday, October 8, 1926. This meeting will be in the nature of a conference on the engineering phases of cotton production.

However, the conference is of interest not only to agricultural engineers, but to every man in the Southwest interested in the advancement of Southern agriculture.

Papers of unusual interest and value will be presented on cotton planting, use of machinery, use of electricity, problems of the cotton farmer, and the methods used to secure greater production per man.

Farm implements and hardware dealers, editors, farmers, county agents, Smith-Hughes teachers, farm equipment manufacturers and professional engineers are cordially invited to attend this meeting.

The full program and place of meeting will be announced shortly. Full information may be obtained from Deane G. Carter, Fayetteville, Arkansas, or G. E. Martin, Stillwater, Okla., chairman and secretary, respectively of the Southwest Section of A.S.A.E.

C.R.E.A. Reports Good Progress in Rural Electrification

RURAL electrification development is progressing at a more rapid pace than would have been thought possible a few years ago. That it has passed the theoretical stage and has now become a practical reality was the keynote of the report made by E. A. White and Frank D. Paine, director and assistant director, respectively, of the national Committee on the Relation of Electricity to Agriculture at its third annual meeting held in Chicago, August 10. The report pointed out that the demands from farmers for electric service are multiplying, while an increasing number are putting electricity to work at tasks other than lighting. Electric light and power companies are establishing rural service departments with men in charge devoting full time to the work. Rate and service regulations, designed to meet rural conditions, have been developed and made official rulings by regulatory bodies. Manufacturers are showing an increased interest in the problem. The term "rural electrification" now makes its regular appearance in the agricultural, local, and metropolitan papers.

In view of these developments the report pointed out that there is no longer any question as to whether or not rural electric service on a national scale will be a reality. It is already here and lines are creeping out with accelerated momentum. The big question now appears to be how rapidly and how intelligently it will grow.

In cooperation with the national committee, state committees have been set up and are actively at work in twenty states, of which twelve have built one or more experimental lines. In these twenty states eighty-six separate and distinct lines of investigation are now being carried on and one hundred and sixty different manufacturers have contributed equipment for use on the experimental lines and for investigational purposes.

Principal among the eighty-six projects now being studied

by the twenty state committees appear those having to do with household investigations, including cooking, laundry, cleaning, and lighting. The investigations of particular interest to dairy farmers include water supply, ventilation, sterilization of equipment, feeding, milking, separation, and the like. The poultry experiments have embraced the study of effect of light for stimulation of egg production, brooders, incubators, food preparation, etc. East of the Rockies and in intensive vegetable growing districts a great deal of interest is being paid to experiments in the use of electricity in the development of overhead irrigation.

During the past year there has been an increase of three state committees. New committees were formed in Michigan, Nebraska, and South Dakota. The other seventeen states with active committees include Alabama, California, Idaho, Illinois, Indiana, Iowa, Kansas, New Hampshire, New York, Ohio, Oklahoma, Oregon, South Carolina, Virginia, Washington, and Wisconsin.

During the year the representation on the national C.R.E.A. was increased by the addition of representatives from the General Federation of Women's Clubs and the American Home Economics Association. Membership of the Committee on the Relation of Electricity to Agriculture now includes the National Electric Light Association, American Farm Bureau Federation, American Society of Agricultural Engineers, the Departments of Agriculture, Commerce, and the Interior of the federal government, National Association of Farm Equipment Manufacturers, General Federation of Women's Clubs, American Home Economics Association, National Grange, and the individual plant manufacturers' group.

Personals of A.S.A.E. Members

F. D. Cornell, Jr., instructor in farm mechanics at the University of West Virginia, is author of a bulletin, entitled "Farm Water Supply and Sewage Disposal in West Virginia," (Bulletin No. 206), just issued by the West Virginia Agricultural Experiment Station.

L. J. Fletcher and **James Koeber,** associate professor and instructor of agricultural engineering, respectively, of the University of California, are joint authors of Bulletin No. 17, entitled "Farm Mechanics in the Agriculture Curriculum," just issued by the division of agricultural vocation of the University of California and of the State Board of Education.

M. L. Nichols, professor of agricultural engineering, Alabama Polytechnic Institute, is joint author with C. B. Chambers of a bulletin (Circular No. 49) issued by the Alabama Agricultural Experimental station, entitled "Protecting the Farm Against Fire."

A. S. A. E. Organization—1926-1927

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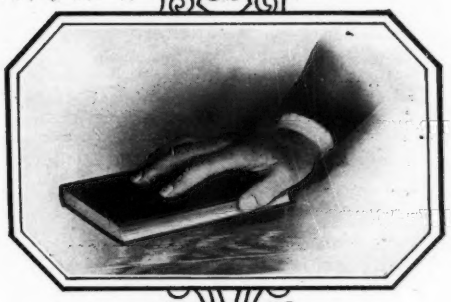
*Denotes non-member of A.S.A.E.

Let's Get Down to Fundamentals



Push a book along the table. Note the drag due to the friction of sliding one surface over the other.

Place the book on pencils. It moves easier because **rolling** contact is substituted for sliding friction. But note the tendency of the rollers to change direction—and then to resist movement in the original direction.

Place the book on balls. The slightest touch starts the book across the table. And note particularly that the balls show no tendency to change the direction in which you are moving the book. Nothing rolls so easily, so true, so free of friction as a ball. **So it is with the New Departure Ball Bearing.**

New Departure Quality Ball Bearings

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Wilhelm Holzwarth, representative, Advance-Rumely Thresher Co., Berlin-Steglitz, Germany.

F. H. McCormick, engineer, electric range division, Edison Electrical Appliance Co., Chicago, Ill.

Otto H. Meili, time study department, Chain-Belt Co., Milwaukee, Wis.; designing and testing, Neill-Blumberg Co., New Holstein, Wis. Adress: 2030 Jackson St., New Holstein, Wis.

W. L. Paul, machine designer, John Deere Plow Works, Berkeley, Cal.

Clara Woolworth, director women's division, educational department, J. B. Colt Co., New York City.

W. D. Wright, rural supervisor, Empire Gas & Electric Co., Geneva, N. Y. Address; c/o E. C. Lautenslager, P.O. Box 5, Geneva, N. Y.

Transfer of Grade

R. A. Palmer, RFD 1, Port Clinton, Ohio.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Lloyd N. Brown, field engineer, University of California; U. S. Department of Agriculture; California State Division of Water Rights. Mail address c/o Colberg Motor Boats, Stockton, Cal.

Evans Curry Crow, field engineer, Portland Cement Association of Pittsburgh, Pa., Box 520, Uniontown, Pa.

E. Courtland Eaton, irrigation engineer, State Department of Public Works of California, 625 Forum Bldg., Sacramento, Cal.

C. V. Waddington, engineer, Kansas Gas & Electric Co., Wichita, Kansas. Mail: 518 S. Vine Street, Wichita, Kans.

R. H. Wileman, assistant in agricultural engineering, Purdue University, Lafayette, Indiana.

E. V. Willard, commissioner of drainage and waters, State of Minnesota. 202 Old Capitol Bldg., St. Paul, Minn.

Employment Bulletin

Men Available

AGRICULTURAL ENGINEER, married, age 29, 1922 graduate of Iowa State College in agricultural engineering, now assistant engineer in construction department of International Railways of Central America, desires position where permanent residence is possible, preferably experimental or production work, or management of reclamation project or large ranch. Ten years experience in general farming with power equipment, experimental and teaching work, and construction work. Can speak Spanish, also some French and German. MA-130.

WORKS MANAGER available. Seventeen years experience in the designing and manufacture of tractors, harvesting machines, and earth-working tools. Sales experience in United States, Canada, England, France, and Italy. Write for interview. MA-132.

AGRICULTURAL ENGINEER, graduate of University of Illinois, nine years teaching experience as assistant professor in one of the largest universities of the central west. Eleven years manufacturing experience with one of the large tractor and farm implement builders. Experienced in production, design, and management. Desires position preferably as extension agricultural engineer or experimental or production manager work. MA-133.

AGRICULTURAL ENGINEER, single, age 26, graduate of University of Nebraska, College of Agriculture, with two years' practical experience in advertising and sales work, would like position in similar work preferably in South or Central America. Very good at drafting, designing, and photography of farm implements. Can speak a little Spanish. Has had a few articles published. Would submit samples of work. MA-134.

AGRICULTURAL ENGINEER, 1917 graduate Iowa State College, ten years experience in highway; city; drainage; irrigation; concrete products; and concrete construction work. Available for immediate employment. MA-135.

Positions Open

AGRICULTURAL ENGINEER wanted to fill position at Preston, Cuba. Knowledge of Spanish desirable but not absolutely necessary. Farm experience, knowledge of gas and steam engines, and such machinery as ordinarily used on large sized farms is essential. Salary $150.00 to $175.00 per month, according to experience. Single man preferred. PO-116.